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GI ENTS.

EDITORIAL NOTES.

The work of the College in all its departments has shown during the past year a very remarkable increase, and it has been found necessary to increase both the in-College teaching staff and also the research and advisory staff. The number of students entered for the 1912-13 session is a "record," there being 162 students in residence, the increased accommodation both in College and at the Coldharbour farmhouse being entirely taken up, whilst the newly-built houses in Oxenturn Lane, all of which are available for lodgings, are also filled. The requests for lectures have been in excess of the number which can be given, and enquiries, samples for analysis, investigation and report, have been very largely increased in numbers.

Now that members of the Research Staff are more free to travel about the district, the effect of such intimate contact with agriculturists and horticulturists is seen in the increasing number of inquiries received, and it is most gratifying to observe the great increase of confidence on the part of practical men in the assistance which can be afforded by the College Staff, and the source of many of the enquiries shows that the College is performing not merely a local but a national function.

The proposed delegation of some of the work of the College —Short Course Work—to other institutions to be established in the province (Kent, Surrey and Sussex) will enable it to develop more fully some of its higher functions of both teaching and research work, and whilst the practical side will be, as in the past, kept well to the front, the academic side will possibly receive more attention. The importance of the College as representing the highest educational and

investigation work of all the institutions in the province, a position which has been defined by the Board of Agriculture, necessitates a development of this academic side, and the effect of the raising of the standards of both educational and research work cannot fail to be of the greatest use to all those who partake of the advantages and opportunities afforded by the College.

But this development of the standard of work must cause increased expenditure, for it must be obvious to any but prejudiced observers that a College and Farm attached cannot be suited for all varieties of agricultural and horticultural production, general farming, sheep farming, dairying, bullock feeding, poultry, fruit, market-gardening, hops, forestry, etc., and that therefore many of these which are obviously not suited to the soil and climatic conditions of the district must be carried on at a loss financially, but the educational value of the teaching is the main point, and there is no danger that the student, if his teaching be in proper hands, will be led to suppose that under all conditions will these various industries be remunerative, whilst their existence under unfavourable conditions with their financial results will be a most valuable object lesson and experience to him. Were the farm merely used for the purpose it is best suited for, the scope and experience of the teaching would be merely local and of considerably less value.

Considerable progress has been made since the last issue of the *Journal* with the organization of Agricultural Education and Research in England by the Board of Agriculture, the necessary funds being assigned to the Board by the Development Commissioners. Wye College is to be the Collegiate centre for the South Eastern Province comprising the counties of Kent, Surrey and Sussex, where the longer courses of instruction (for degrees and diplomas) are to be carried on, whilst it is suggested that short course work be conducted at other institutions to be established at such centres in the province as shall be considered necessary. Wye College will be the headquarters of the Research and Advisory Work, which will be placed in more intimate touch with the agricultural and horticultural industries of the province by means of travelling agricultural organizers, whose duties will

include the bringing to the notice of the College workers any problems of those industries which require investigation and also of informing the practical workers in those industries of any investigations carried on at the College which have borne useful fruit. A commencement had been already made in this direction by the appointment of a Research and Advisory Staff at the College, and a grant has been made by the Board of Agriculture towards the cost of this staff. Mr. Theobald and Mr. Salmon will be in charge of the Entomological and Mycological branches respectively, Dr. Eyre will be in charge of the research work on the Chemical side, Mr. Garrad will act as agricultural organizer and keep that active connection between the College and the land industries of the province which is so essential, whilst Mr. Wellington, as manager of the Research Fruit Plantation, will be in charge of the outside work of the Horticultural Department. The additional accommodation required will be provided in the new block of buildings, towards the cost of the erection of which a Government Grant has been promised by the Development Commissioners.

The proposal to which reference was made in the last *Journal* of establishing a Plantation for Research in Fruit and Hop-growing has now assumed definite shape on the offer of the Board of Agriculture to make a grant of £500 per annum towards the upkeep of the Station, provided that it were under the management of Wye College and that the land and necessary buildings were provided by the locality. The Kent County Council sanctioned a grant by the Education Committee of £1,500, and the balance of £1,000 has been guaranteed through the public spirit of a gentleman who is identified with every movement for the good of his neighbours in the county. A description of the plantation, which is situate at Malling, near Maidstone, and of the proposed work, will be found under the report of the Horticultural Department. At a very representative meeting of Fruit Growers held at Maidstone in February, it was resolved that the name of the station should be the Wye College Fruit Station, and whilst the details of the scientific work carried on will be in the hands of a Committee which will also have in its purview the other research work which is or will be carried on in Fruit-growing in

England, the management will be by the Wye College Governors, and a large Consultative Committee of Growers will meet from time to time to consider useful lines of work and any results which may have been secured.

The twelve "provinces" into which England has been divided for the purposes of agricultural education and research include the area comprising the counties of Kent, Surrey and Sussex—one of the most interesting districts of England from a farming point of view, as there are represented the larger industries of corn-growing, meat production, sheep raising and dairying, and also the more intensive industries of fruit and hop growing, and of market-gardening, both in the open and under glass. The thin soils overlying the chalk on the North and South Downs, the heavy soils of the Weald, and the rich grazing lands of the Marshes are all widely different in their systems of farming and management, and the trade of the south and south-east coast watering-places is an important item in directing agricultural and horticultural production. The promotion of the industries of the province therefore demands a somewhat comprehensive scheme, and it falls to the lot of the Joint Advisory Council (formed of representatives of the County Councils of the province) to prepare such a scheme. Wye College would naturally be the collegiate centre acting for the province and would undertake all the higher teaching and research work for the province; on the Staff of the College should be the agricultural and horticultural organizers acting for the counties—an organizer being accredited to each county. The organizers would frame the scheme for the work in each county, such work comprising lectures in various branches of agriculture, commercial fruit-growing, veterinary science, poultry work, entomological and mycological subjects, etc., etc., the lectures being given partly by the county and partly by the College Staff, all overlapping of the functions of the two sets of lecturers being eliminated by the organizer acting in intimate connection with both College and county authorities. The county work supervised and arranged by the organizer would include all demonstration work (*e.g.*, pruning, the identification of the common insect and fungus attacks for orchard workers, manual processes for farm workers, experimental plots for testing or demonstrating

use of manures, methods of cultivation, testing new varieties, etc.), the arranging of conferences and of farmers' visits to the Collegiate centre, in fact, generally, the development of the outside work in the county and the securing of the co-operation of the services of all the experts in the province to promote a thoroughly efficient scheme. Associated with the Collegiate centre would be the Farm Institute and Farm Schools, where short courses of instruction would be carried on, or specialised courses in subjects for which the conditions of the Institute were specially suitable. Among subjects for such specialised courses, some of which might be undertaken at the Collegiate centre, could be mentioned Poultry work, Dairying, Entomological and Mycological subjects for Horticultural Instructors, Rural Science for Schoolmasters, Spraying Machines and Spray Materials. The Fruit Research Station would be the head-quarters for the province for the investigation work in Fruit-growing, but sub-stations for testing and extending the work of the central station would be established in the fruit-growing districts of the Province.

The following changes have occurred in the College Staff :—

J. Mackintosh, N.D.A., N.D.D., has been appointed Dairying and Dairy Farming Advisor to Reading College; he is succeeded by C. Hutchinson, B.Sc. (Agric.).

Dr. Auld has been appointed Professor of Agricultural Chemistry, Reading College; he is succeeded by D. R. Edwardes-Ker, B.A., B.Sc.

H. P. Hutchinson has been appointed Botanical Advisor to the Midland Agricultural and Dairy College; he is succeeded by J. Kendall, B.Sc.

G. H. Garrad, S.E.A.C. Dip., is transferred to the Advisory (Agric.) Department.

J. V. Eyre, Ph.D., has been appointed Research Chemist.

G. Smith, B.Sc. (Agric.), S.E.A.C. Dip., has joined the staff of the Botanical Department.

S. Rothwell, S.E.A.C. Dip., has joined the Agricultural Staff.

Viscount Ipswich, P.A.S.I., S.E.A.C. Dip., has joined the staff of the Estate Management Department.

C. W. M. Holroyd has joined the staff of the Horticultural Department.

H. Howes has been appointed Poultry Superintendent.

J. Robbins has been appointed Farm Bailiff.

C. W. Mason, S.E.A.C. Dip., has come back to work in the Entomological Department.

The Rev. E. Lambert, Vicar of Wye, has been appointed Honorary Chaplain of the College.

It is most satisfactory to record that eleven old Wye Students are now in responsible positions on the Staff of the College, Messrs. Carter, Chandler, Garrad, Holroyd, Lord Ipswich, Jemmett, Mason, Rothwell, C. S. Smith, G. Smith, Wellington.

At the recent meeting of the Association of American Agricultural Colleges and Experiment Stations attention was drawn to the increasing number of students attending these Colleges from the cities and towns, and to the wide-spread interest in country life and industries which was reflected at many Agricultural Colleges by the enrolment of students in which the farmer's son is in a minority. In the New York State College, ten years ago, ninety per cent. of the students came from home farms, to-day only forty per cent. are of the farming class. The same is true of our English Colleges, the large increase in the number of students at Wye, for example, is due mainly to those coming from the professional and commercial classes, the number of farmers' sons remaining practically stationary. This point has often been argued in the College *Journal*, and insistence has been laid on the fact that it is not the class of student which attends an Agricultural College which determines its utility, but the after occupations of those students, and it is found that the occupations in which students engage themselves after leaving Wye College are, in the case of eighty per cent., connected with Agriculture or Horticulture. From a national and perhaps sentimental point of view, it is sad to see so many promising young men tempted abroad either by a higher rate of remuneration than at present obtainable in this country, or by conditions of farming or fruit-growing which require a less expenditure of capital and more possibilities of using a man's own brains and muscles. It must always be remem-

bered that Wye College is not a "rich idlers'" College, and that most of the men who attend the College have to earn their living by the knowledge they have gained and are not in a position to invest more capital. Those who come with the idea of engaging in farming or fruit-growing and are prepared with the necessary capital, are always advised to spend three or four years in gaining practical experience on the farms of successful business men before embarking on their own responsibility, but the difficulty of obtaining good farms in this country is yearly increasing and has driven many good men abroad.

A considerable number of old students have settled down farming and fruit-growing in England and Ireland, and the following appointments of old students have been recorded. It would be an excellent plan if all old Wye students would communicate with the Principal on obtaining or changing an appointment, as applications to fill vacancies are often received, and it is possible that all likely candidates are not informed of them owing to the absence of knowledge of their whereabouts.

Adam, W., Colonial Office, Surrey, Ceylon.
Baxter, S. E., Superintendent, Sumatra.
Boyle, C. N., S.E.A.C. Dip. Agriculturalist, Egyptian Agricultural Department.
Cave Browne, E. A., Assistant Manager, Ceylon.
Chesney, C. C., Indian State Railways.
Dowling, R. N., Agricultural Organizer, Lindsey (Lincs.) C.C.
Dunlop, W. R., West Indian Agricultural Department.
Edwards, R., Land Agent, Shropshire.
Garnett, E. R., Surveyor, Canadian Pacific Railway.
Garrad, G. H., N.D.A., Wye College Agricultural Advisor.
Gillman, W. R., Superintendent, Sumatra.
Hay, R. A., Land Valuation Department.
Heymann, W. G., Land Valuation Department.
Hitchins, P. E. N., B.Sc. (Agric.), Advisor on Manurial Requirements of the Tea Soils, India.
Holroyd, C. W. M., Wye College Horticultural Department.
Viscount Ipswich, Wye College Estate Management Department.
Jepson, F. P., Entomologist, Fiji.

Keable, C. L., S.E.A.C. Dip., Aboukir Land, Egypt.
Kingsford, G. N., Indian State Railways.
McGowan, W., Land Agency, Lincs.
Orwin, C. S., Director Agricultural Economic Research, Oxford.
Rothwell, S., Wye College, Agricultural Department.
Saunders, C. B., Botanist, Cirencester Agricultural College.
Strickland, C. E., Assistant Botanist, Reading College.
Tonks, H., Assistant Manager, Ceylon.
Williams, A. N., Indian State Railways.
Wilson, R. M., Land Agency, Shropshire.

It is with sincere regret that we have to record the death of W. B. Burgess, B.Sc., one of our most promising Students, who, after a distinguished career at the College, had been appointed on the Horticultural Staff, and whose originality and thoroughness would have been of inestimable value to the teaching and research work of the College. After lingering sixteen months, he succumbed to injuries sustained through diving into shallow water at his home. His strength of character and sincerity were such that all connected with the College deeply mourn the untimely death of one whose future seemed so assured and so full of promise.

The Secretary will be glad to have old copies of the Journal, especially Nos. 2, 3, 4, 5, 6, 7, 8, 11 and 12, in order to have an additional complete set.

REPORTS

FROM THE

AGRICULTURAL

AND

DAIRYING DEPARTMENTS

THE FARM.

By C. Hutchinson, B.Sc.

The principles on which the farm has been conducted during recent years have been observed without material change during the past year. The season, generally, was one of the worst ever experienced since the Cold Harbour farm was taken over, and the result of the year's work is in consequence less satisfactory than has usually been the case.

February and March were particularly wet months and spring work was much delayed. The sowing of spring corn was commenced on March 27th. Favourable weather followed and sowing was complete by the end of the second week in April. In spite of continuous hot, dry weather, in this and the following month, corn grew exceptionally well, and the best of results were anticipated. Thunderstorms in later summer caused lodging of most of the barley. The harvesting difficulties were increased, and a very wet August prolonged the carting to September 7th, with consequent shedding of grain and damage to quality. The oat crop suffered more than the barley, and a large proportion of this grain was retained for feeding purposes.

The varieties of grain grown, with the yields and prices obtained follow :—

Wheat :—

Victor	4 qrs. per acre	37s. per qr.
Red Standard	4 ,, ,, ,,	34s. and 39s. per qr.
Burgoyne's Fife	3 ,, ,, ,,	39s. per qr.
Blue Cone	5 ,, ,, ,,	34s. per qr.

Part of the Red Standard and the Blue Cone were harvested in poor condition, and kiln dried.

Barley :—

Burton Malting	$3\frac{3}{4}$ qrs. per acre	32s. per qr.
Prize Prolific	4 ,, ,, ,,	40s. per qr.
Standwell	4 ,, ,, ,,	32s. per qr.

Oats :—

Abundance	$7\frac{1}{2}$,, ,, ,,	24s. per qr.
Cluster	8 ,, ,, ,,	
Beseler's Prolific	9 ,, ,, ,,	24s. per qr.
Black Tartarian	6 ,, ,, ,,	24s. per qr.

The adverse season proved no less harmful to the potato crop. The practice of shallow ploughing in of farm-yard manure in the autumn, and leaving the deeper ploughing to the spring, as a preparation for potatoes proved disastrous. Second ploughing was delayed till March and April, with the land still wet, and this being followed by the long period of drought, a good tilth was not obtainable. The early varieties came up a thin plant and produced less than average yields. A striking feature during the summer was the superiority of the crop from imported seed, over that from seed once grown at Wye. This characteristic extended to the main crop varieties. The risk of using cut sets in a dry season was exemplified. Many of the half tubers failed to make any growth, and this was so common in one variety that a small area was ploughed up and sown with mangolds. Cut seed has frequently been used in past seasons with the best of results. The dressing of the early potatoes with some new forms of nitrogenous manure was tried with results reported elsewhere. The quality of the potatoes was good and satisfactory prices were realized.

The persistent wet weather of August prevented the usual amount of spraying of the main crop potatoes being done, and the conditions being those most favourable to the rapid development of the Late Blight fungus, the disease made rapid headway, and checked the growth of the crop. The tubers, when lifted, proved of good quality, a little affected by disease, and with a high percentage of set size potatoes. The prices realized throughout the winter were up to the highest market quotations.

The varieties grown are given below:

First Earlies.

Epicure.
Sharpe's Express.
Royal Standard.

Second Earlies.

Eclipse.
British Queen.

Main crops.

Beau Ideal.
Mayfield Blossom.
Cora.
Scottish Triumph.
Dalhousie.
Dalmeny Beauty.

For Early Potatoes the prices ranged from £8 per ton for the first lot sold, to £3 12s. per ton for the Second Earlies. The average crop for the First and Second Earlies was slightly over six tons per acre.

The Maincrop varieties yielded from seven tons to nine tons per acre, and these were sold during the winter at 90s. to 100s. per ton.

During the planting season we were favoured with a demonstration of potato planting by the " Aspinwall " planter. The European agents for this American machine kindly sent down one of their engineers to give the demonstration. Some difficulties in adjustment occurred, and the general result of the trial was probably an injustice to the machine. The makers are strongly of this opinion and promise a further demonstration this year, when we hope to see the full 98 per cent. regularity of planting of which the machine is reputed capable. The planter simultaneously makes the drills, sows the artificial manure, plants the potatoes, and finally throws up the ridges. A pair of horses can easily work the machine, and if it proves to justify in this country the praise bestowed on it in America, it will be a machine no potato grower can afford to be without.

A further interesting demonstration was furnished by Messrs. Curtis and Harvey, who sent a representative to show

the method of subsoiling by blasting. A number of trees were uprooted by the explosive Cheddite. Later, work was commenced on a quarter acre plot in King field. This plot will be under Mangolds during the coming year, and this crop will afford an excellent opportunity for the value of this novel method of cultivation being ascertained.

Conditions so unfavourable to the potato crop resulted in partial failure of the mangold crop. A late second sowing produced some fair roots in a thin crop. Small areas of swedes and cabbage gave unusually good crops, which served the cattle until the end of December. Strict economy in the use of roots, favoured by a mild open winter, enabled the available supply to serve our most pressing needs.

Less than our usual acreage of wheat has been sown in autumn. This has stood the winter well. Variety trials are again being conducted. The varieties chosen are :—Garton's "Victor," a wheat grown here for some years past with satisfactory results, "Blue Cone," a selected wheat of the Rivet type, grown at Wye for the second year, "Burgoyne's Fife," a hybrid wheat brought out at Cambridge also being grown a second time, "Wilhelmina," a *Dutch* wheat, which has been extensively tried in the Eastern counties, where it has established a favourable reputation, and "Champion," an Anglicised red wheat introduced by Marsters ; this is exhibiting remarkable tillering power.

Our intention is to give all new cereals sown a trial sufficiently long to enable a definite opinion of their value to be formed when grown under different seasonal conditions. Similar trials are being made with barley and oats, some newer varieties being tried alongside others of established reputation. The trial barleys sown are Golden Grain, Invincible, New Binder, Hallett's Chevalier, Brewer's Favourite, Maltster, and Beaven's Selected Archer, Plumage and Archer-Plumage Hybrid. The varieties of oats for trial are Beseler's Prolific, Regenerated Abundance, Triumph, Leader, Yielder and Record, a selection which includes some of the most promising oats introduced in recent years. Our intention is yearly to sow a small quantity of regenerated or selected seed of the varieties of wheat, oats and barley which are grown in quantity on the farm, and from this seed to

produce enough for our requirements. Our further intention is to select from the varieties tried some most satisfactory, and by repeated sowing of home-grown seed and comparison with the yield and quality resulting from new seed from the same original source, to settle locally the question of frequency with which it is desirable change of seed should be made.

The usual acreage of clover was sown in 1912, and an excellent plant was obtained throughout. While two fields have stood the winter well, the field in the four course rotation has suffered from a severe attack of clover sickness, and it has been decided to introduce sainfoin for meadow and white clover for pasturage on the area which would ordinarily have been sown with red clover.

The 1912 seed hay crops were fairly good, and being well harvested a good supply of superior fodder was available during winter. The meadow hay crops too were above the average and were gathered in record time. The quality of the hay now produced on the Silks meadows has much improved during the past two seasons, the manurial applications of the past having produced a uniform covering of clover and trefoil plants. A secondary result of this change should be an increasingly large return in years to come. Manurial experiments are being made on meadow land, the first results of which will be available next year.

The report on the live stock of the farm is a favourable one.

The whole dairy herd was subjected to the tuberculin test in the Autumn, when three cows reacted. Steps were taken to free the herd from all reacting animals, and we are pleased to record that the present herd, which includes some purchased cows, has recently been passed by the veterinary surgeon. All cows will now be required to pass the tuberculin test before joining the dairy herd. The stock bulls are certified as having passed the test. An abnormally large number of cows have been fattened during the past winter. These cows—many of which were advanced in years—realized a good average of £18 1s. 6d. each.

The practice of rearing all home-bred calves has been continued, and the number of young homebred cattle exceeds that of any previous year. The high expectations formed of the milking qualities of homebred heifers has not

been realized, and it is not until the present yearling heifers are available for the dairy herd that better results can be expected. Of these heifers six are out of our best cows, and by the Dairy Bull bred by Lord Rothschild at Tring, which is descended from the famous cow Darlington Cranford V. In our case, where a dual purpose herd is kept, the danger of an excessive tendency in either direction is always liable to occur. The loss in one direction is the gain in the other, for the heifers, which have disappointed us in milk, have proved excellent animals for the butcher. The improved shed and yard accommodation provided at Silks during the past summer proved of immense benefit during the past winter, both in the health and condition of the young stock, and in the great economy of fodder and litter effected. About thirty head of homebred cattle are avilable for summer grazing, and these are in the best of grazing condition.

The fattening of cattle during the past year has proved profitable. Ten Irish steers were fattened off during the winter, and these left a small estimated profit per head in addition to the manurial values of the foods consumed. Young homebred cattle have realized satisfactory prices when sold to the butcher. In all, thirteen have been sold at an average price of £21 7s. 6d., the average age being slightly under two years. These cattle, for the most part, had never been out to grass, and others had been grazed for one summer. Best returns were made by a Shorthorn Sussex steer, which at twenty-one months realized £22 15s. 7d. when sold at 13s. 6d. per score. A Shorthorn-Galloway sold for £20 5s. at the age of twenty months. The beef cows, from which the above animals were bred, have been increased during the past year by the purchase of two Aberdeen Angus and two Hereford heifers. The latter now have Hereford heifer calves at foot, and the development of these calves in the home of the Sussex will be watched with interest.

Sheep.

The Southdown flock has given satisfactory results during the year. The crop of lambs was an average one. The attacks of stomach worms, which had wrought great havoc during the three preceding years, were less severe. Such

preventive measures as were suggested by past experience were taken, and these may have reduced the severity of the attack. Worms were proved to be present in considerable numbers. As similar measures will be taken during the coming season, a repetition of last year's results would enable us to attribute with greater reliance, the success to our efforts. An attack of tetanus, following late castration of some Down lambs, resulted in a loss of eleven lambs in spite of daily veterinary attention. Forty ram lambs were retained for the Ashford sales in October, and these realized an average price of 50s. 4d. This price was a considerable drop on that of the previous year, and was unsatisfactory. Draft ewe tegs and wether tegs have realized highly satisfactory prices.

The Kent flock produced a very light crop of lambs. Both ewes and followers remained healthy and good tegs resulted.

The breeds kept for educational purposes comprise Dorset Horns, Lincolns, Suffolks and Hampshire Downs. Lambs from the first-named breed, crossed with the Southdown, sold at the age of fourteen weeks for 50s. each, the lambs being twins. Southdown-Suffolk tegs sold at 58s. each, when ten months old.

Southdown wool was sold at Guildford and the Kent wool at Ashford. The prices obtained with those of 1911 are given below :—

	Price per lb. of washed wool. 1912.	1911.
Southdown Teg Wool ..	1s. 1¾d.	1s. 1½d.
,, Ewe Wool ..	1s. 1½d.*	1s. 1½d.
Kent Teg Wool	1s. 0¼d.	11d.
,, Ewe Wool	11½d.	10¾d.

Pork was an improving trade as the year advanced. Ninety-seven fat pigs were sold. This number was smaller than usual, consequent on a reduction in the stock of breeding sows. Some good prices were realized, *e.g.*, £11 5s. for a fat sow, £11 10s. for a Mid.-White × Large White Hog, which scaled thirty-nine stones at the age of eleven months, £7 each for a pair of Mid.-White × Large Black Hogs a little over nine months old, and £4 12s. 6d. each for a pair similarly bred

* Highest price at the sale for ewe wool.

at the age of twenty-one weeks. The breeding stock was increased to ten sows by the purchase of two Mid.-White sows, three Large White sows, and two Large Black sows. These with a selection from the older stock were in full profit when swine fever appeared on the farm. To meet a temporary deficiency in store pigs a team had been purchased in the market, and the disease appeared amongst and was confined to these. Slaughter of the whole stock was ordered. The compensation received was £126 10s., a fair market value for the stock slaughtered, though not the real value of specially selected stock of proved worth. All restrictions are removed, but the Cold Harbour premises will be kept free from pigs till the autumn. Restocking is proceeding, the pigs being lodged at Silks. The herd it is proposed to establish is similar to the one destroyed and consisting of:

1 Middle White Boar.
2 Middle White Sows.
2 Berkshire Sows.
2 Large Black Sows.
4 Large White Sows.
1 Tamworth Sow.

New premises for breeding sows and young pigs are being erected near the site of the old premises now destroyed. Experimental work on pig feeding was conducted with a view to ascertaining the suitability of Gram and Sharps as a feed for pork pigs. A comparison was made with pigs fed on Separated Milk and Sharps. The experiment was only regarded as a preliminary to further work which is now suspended until pigs are available.

An extended trial has been made on the use and value of Para Rubber Seed Cake to Dairy Cows and to fatting cattle, which proves the cake to be a safe and valuable one.

Experiments were made on the manuring of Cabbages, but a first planting resulting in a patchy plant and partial replanting following, the experiment was robbed of much of its value, though the results are useful as a basis for the modifications introduced into this season's manuring.

Trials were also made with new nitrogenous manures used as top dressings for potatoes and for meadow land. Similar experiments are again being conducted, and the results should

demonstrate the value of top dressings for these crops, and the relative values of the manures tried for the above purposes.

During the year, some necessary improvements have been effected on the Cold Harbour premises. The food store has been repaired and enlarged, and is now quite satisfactory.

For educational purposes the farm has been used as far as possible. Certificate students regularly devote half of three mornings per week to practical work under members of the staff. Afternoon work is done as previously. Regular demonstrations in the new Implement Sheds are given to all students, and prove of the greatest value.

THE DAIRY HERD.

By T. E. W. Dobson.

During the past year the results from this section of the live stock of the College Farm have been somewhat disappointing.

The system of management commenced four years ago with a view to illustrate in a practical fashion the keeping of a dairy herd for the production of market milk has been continued throughout the past year.

The method of keeping milk records in practice at the Farm was fully explained in *Journals* No. 18, pp. 63, 64, and No. 19, pp. 33, 34. This method has been continued together with the addition of a column giving the length of the dry period before calving; this latter addition was first made in *Journal* No. 20.

During the past season four heifers have completed a lactation period, and in making up the table of records it has been considered advisable to classify the cows and heifers separately.

The average yield for the cows—6,665 lbs.—cannot be said to be very satisfactory, there being no material increase over the previous year.

There is no cow of outstanding merit as a milk producer, the highest yield being 8,777 lbs. produced by Shorthorn 22. Comparing the yield of some of the cows with the amount they produced in the previous season, three cows—L 28, S 5, and S 20, show notable increases. On the other hand four cows—L 22, S 1, S 8, and S 14—show a very marked falling off, particularly L 22, the decrease in this case being 2,392 lbs.

For some reason or other the quality of the morning's milk has been distinctly poor, no less than ten cows, Ayrshire

included, average under the legal limit of 3 per cent.; but the presence of two Jerseys in the herd ensure that the mixed milk is always of satisfactory quality.

Taking the average quality of the two milkings, all except the milk from two cows—S 12 and S 20—are well above the

MILK RECORD OF DAIRY HERD. SEASON 1911-12.

No. of Cow.	Weeks Dry before Calving.	Weeks in Milk.	Actual Yield of Milk.	Average Daily Yield.	Average per cent. Fat in Milk. Morn.	Even.	Average	Calculated Yield of Milk in lbs of three per cent. Fat.	Number of Calves.
Lincoln :									
No. 13	17	52	6149	16.8	2.92	3.86	3.29	6702	7
No. 22	16	39	7966	29.1	2.65	3.71	3.18	8443	3
No. 26	17	42	5421	18.4	2.84	3.87	3.27	5908	3
No. 28	7	57	7273	18.2	3.00	3.90	3.37	8133	3
No. 30	10	60	6179	14.7	3.57	4.22	3.89	8012	2
Shorthorn :									
No. 1	16	39	4383	16.5	2.89	3.84	3.27	4777	6
No. 5	30	43	6525	21.6	2.72	3.94	3.21	6981	6
No. 8	14	43	7118	23.9	2.89	4.07	3.48	8256	4
No. 11	5	48	6909	20.5	2.90	3.80	3.35	7715	3
No. 12	30	33	4169	18.0	2.69	3.79	2.97	4127	3
No. 14	10	47	7257	22.0	3.11	3.99	3.45	8344	6
No. 20	9	50	8523	24.3	2.69	3.47	2.98	8466	5
No. 32	?	47	8777	26.6	3.08	4.10	3.62	10594	4
Average for year of above 13 Cows			6665						
Ayrshire	8	44	7112	24.8	2.83	4.17	3.40	8060	2
Jersey (Cowslip).	?	44	3440	11.5	4.69	5.33	4.91	5360	3

standard. Comparing the quality of the morning and evening milk the average difference in butter fat is practically 1 per cent., and this fully agrees with the differences usually found where the intervals between the two milkings are fourteen-and-a-half hours and nine-and-a-half hours.

Particular notice should be taken of quantity and quality of the milk produced by S 12. This cow gave the lowest yield —4,169 lbs—as well as the poorest in quality, the average of the two milkings being 2·97 per cent. fat. This is a striking piece of evidence against the often heard statement that poor milkers give rich milk.

MILK RECORD OF DAIRY HERD. (See Table, p. 27).

HEIFERS.

No. of Heifer.	Weeks in Milk.	Actual Yield of Milk.	Average Daily Yield.	Average per cent. Fat in Milk.			Calculated Yield of Milk in lbs. of three per cent. Fat.	Number of Calves.
				Morn.	Even.	Average		
Lincoln :								
No. 30	77	8219	15.2	3.29	4.03	3.54	9698	1
No. 36	52	5118	14.0	3.46	4.23	3.66	6243	1
No. 37	47	5455	16.6	3.54	4.22	3.69	6709	1
No. 38	52	5527	15.1	3.09	3.99	3.32	6116	1
Average for year of above 2 Heifers		6079						
Jersey (Jessie)	57	3548	8.8	4.96	5.49	5.17	6114	1

PIG FEEDING EXPERIMENT.

By C. Hutchinson, B.Sc.

This investigation was undertaken to determine the value of Gram as a substitute for separated milk in combination with middlings in the feeding of newly-weaned pigs intended for sale as porkers.

Gram is a food comparatively little used in this country. It is the seed of a leguminous plant (*Cicer arietinum*) indigenous to India. As regards its value as a food it is comparable with the common grey pea of this country, as is shown by the following analysis of samples.

	Dry Matter. Percentage.	Crude Protein. Percentage.	Oil. Percentage.	Soluble Carbohydrates. Percentage.
Peas	88	23	1·5	54
Gram	90	22	4·0	56

A sample of the middlings used had a composition as follows :—

Dry Matter. Percentage.	Crude Protein. Percentage.	Oil. Percentage.	Soluble Carbohydrates. Percentage.
88	14	3·5	62

The digestibility of the Gram was not known, but the digestibility was assumed similar to that of peas and the rations were compounded on the assumption that the starch equivalents of Gram, Middlings and Separated Milk were 70, 74 and 7·6 respectively.

A preliminary trial was made on pigs of twelve to sixteen weeks old, which showed that 1 lb. of Gram per day, which

exceeded the maximum allowance it was proposed to feed during the experiment, could be fed without any ill consequences. Any greater quantity produced some constipation which, however, was readily corrected by the addition of about 4 lbs. of mangolds per day to the diet.

A further preliminary trial showed that the feeding standards for pork pigs as compiled by Kellner allowed sufficient food without waste, when fed three times per day. The animals usually left the trough a first time with some food remaining to return a short time afterwards and clear up the residue. This being the condition desired, the rations given throughout the experiment were in close agreement with Kellner's standards.

In all growing animals the proportionate requirements in protein decline as the animals advance towards maturity. Middlings, which forms the chief food for pork pigs, is too poor in digestible protein to satisfy the needs of young pigs. The deficiency of protein must be met by the addition of some food rich in this ingredient, and it is in this way that separated milk has so high a value, possessing as it does a high percentage of digestible protein in a form readily absorbed by the animal.

Where a supply of separated milk is not available, other foods rich in protein may be used to supply the requisite amount of this ingredient, and it is in this way that Gram was used in the experiment.

Selection of the Pigs for the Experiment.

The pigs were by the same Middle White Boar and out of pure-bred Sows of different breeds.

Litter I., Large White Sow, farrowed Feb. 2nd, 1912, 8 pigs selected from 11 in litter.

Litter II.—Middle White Sow, farrowed Feb. 3rd, 1912, 8 pigs selected from 9 in litter.

Litter III.—Berkshire Sow, farrowed Feb. 6th, 1912, 8 pigs selected from 9 in litter.

Preparation of Pigs for the Experiment.

The pigs on February 28th were offered whole milk, and they took readily to this food by March 7th. During the course of the next week Separated Milk was gradually substi-

tuted for the new, and Middlings and Gram Meal were added, while during the following week water was added to the Separated Milk and the quantity of sharps and gram increased.

The pigs did not take readily to the moderately coarse Gram Meal, but consumed more finely ground meal without waste. By March 23rd the pigs were feeding well, and were considered ready for weaning. A succession of cold days followed immediately, and to this, combined with the change of diet, the poor progress during the following fortnight is attributed.

The twenty-four pigs were ear-marked for identification, and divided into four lots, each lot containing two pigs from each litter. Lots 1 and 2 each contained one hog and one gilt from each litter and were of similar weight—the total weight of Lot 1 being 188 lbs., and that of Lot 2 183 lbs. An early loss of one half-bred Berkshire in Lot 2 was not replaced, and this group throughout contained five pigs and was fed accordingly. These lots were placed in adjoining boxes opening into a covered yard. Lots 3 and 4 weighed 149 lbs. and 140 lbs. respectively at the outset. These were placed in adjoining pounds consisting of an inner sty with a slatted platform as floor, and an open court to which the pigs had free access.

Feeding Arrangements.

The pigs were fed three times per day. The meal was mixed with water, plus the allowance of separated milk, until a suitable consistency was obtained and this was fed immediately to the pigs. During the earlier weeks warm water was used. An opinion is prevalent that long soaking renders meals more digestible to swine, but numerous experiments fail to confirm this idea, and in cases where an advantage from soaking does appear, that advantage is but slight. Results are uniform in showing a gain from soaking where whole grain is fed, the pigs' digestive system presumably being incapable of effectively comminuting and fully utilizing it. Coal slack was fed three times per week, experiments reported in Vol. XVIII. of this *Journal* having proved the necessity of this addition to the diet.

TABLE I.

Weight of Pig.	Kellner's Feeding Standard.				Foods Allowed.			Estimated Contents of Food Allowed.		
lbs.	Dry Matter. lbs.	Digestible Protein. lbs.	Starch Equivalent. lbs.	Lots.	Middlings. lbs.	Gram. lbs.	Separated Milk. lbs.	Dry Matter. lbs.	Digestible Protein. lbs.	Starch Equivalent. lbs.
30	1·35	·195	1·03	I. and III. ..	1·0	·5		1·3	·21	1·1
				II. and IV. ..	1·5		·75	1·3	·21	1·2
40	1·75	·25	1·36	I. and III. ..	1·5	·5		1·8	·26	1·5
				II. and IV. ..	1·9		·95	1·8	·26	1·5
50	2·13	·30	1·69	I. and III. ..	1·8	·6		2·2	·32	1·8
				II. and IV. ..	2·3		1·2	2·2	·32	1·8
60	2·48	·34	2·01	I. and III. ..	2·1	·7		2·5	·38	2·1
				II. and IV. ..	2·7		1·35	2·5	·37	2·1
70	2·81	·37	2·32	I. and III. ..	2·5	·65		2·8	·42	2·3
				II. and IV. ..	3·0		1·2	2·8	·41	2·3
80	3·12	·40	2·63	I. and III. ..	3·0	·6		3·1	·46	2·6
				II. and IV. ..	3·5		1·15	3·1	·46	2·6
90	3·40	·42	2·93	I. and III. ..	3·3	·55		3·4	·49	2·8
				II. and IV. ..	3·8		·9	3·4	·48	2·9
100	3·66	·44	3·23	I. and III. ..	3·6	·5		3·7	·53	3·1
				II. and IV. ..	4·0		·8	3·8	·51	3·0
110	3·89	·45	3·52	all ..	4·8			4·2	·57	3·5
120	4·10	·46	3·80	all ..	5·1			4·5	·61	3·8
140	4·45	·49	4·35	all ..	6·0			5·2	·72	4·4

Progress of the Experiment.

The following tables give only the fortnightly weighings of the groups. The weights given are single weighings only, and when used for the calculation of cost per pound increase during the fortnight, give only approximate results, and are subject to the unaccountable variations in weight which occur from time to time in a thriving animal. Repeated weighings of other individual pigs on successive days were made with the object of ascertaining the degree of reliability of one single weighing, and it is not uncommon to find determinations on one day varying by as much as 3 lbs. in either direction from the mean of the weighings on the immediate preceding and succeeding days even when the conditions are made as uniform as possible. The figures in the columns giving cost per pound live weight increase during the fortnight, must be read in the light of these facts. The general regularity with which the cost of production during each fortnight rises from the eleventh week is of commercial importance in the production of porkers. The small increase of weight obtained in each group during the first fortnight is accounted for by the adverse weather conditions then prevailing, possibly combined with too early weaning. Our experience in other litters similarly fed and weaned at seven weeks old has not supported this latter suggestion, for the pigs have maintained a satisfactory rate of growth.

The observation made regarding the interpretation of the cost of production per pound live weight increase in the fortnight is applicable, with modifications, to the cost of production of one pound during the period, and in a diminishing degree as the period advances. After the first four weeks of the experiment, such variations in weighings as are likely to occur would have but a very slight effect on the figures in the cost per pound in the period column, and these may be considered quite reliable.

For Tables II. and III., see pp. 34 and 35.

In comparing Tables II. and III. the reduction of Lot II. by the loss of a half-bred Berkshire should be borne in mind. Had this pig lived and progressed as its brother in the same group, the last column in Table III. would not have been

TABLE II.

LOT I.—FEEDING: MIDDLINGS AND GRAM.

		During Fortnight.			During Period.		
Age of Pigs.	Weight of Six Pigs.	Cost of Food.	Gain in Live Weight.	Cost of Food to produce 1 lb. Live Weight Increase.	Cost of Food.	Gain in Live Weight.	Cost of Food to produce 1 lb. Live Weight Increase.
		£ s. d.			£ s. d.		
7 weeks	188 lbs.	—	—	—	—	—	—
9 ,,	206 lbs.	8 6	18 lbs.	5.66d.	8 6	18 lbs.	5.66d.
11 ,,	278 lbs.	8 9½	72 lbs.	1.47d.	17 3½	90 lbs.	2.3d.
13 ,,	338 lbs.	11 7½	60 lbs.	2.5d.	1 8 11	150 lbs.	2.31d.
15 ,,	398 lbs.	13 1½	60 lbs.	2.62d.	2 2 0½	210 lbs.	2.40d.
17 ,,	486 lbs.	15 8½	88 lbs.	2.14d.	2 17 9	298 lbs.	2.32d.
19 ,,	571 lbs.	17 9½	85 lbs.	2.51d.	3 15 6½	383 lbs.	2.37d.
21 ,,	631 lbs.	1 1 1½	60 lbs.	4.22d.	4 16 8	443 lbs.	2.61d.
23 ,,	707 lbs.	1 2 2½	76 lbs.	3.5d.	5 18 10½	519 lbs.	2.75d.

Table III.

Lot II.—Feeding: Middlings and Separated Milk.

		During Fortnight.			During Period.		
Age of Pigs.	Weight of Five Pigs.	Cost of Food.	Gain in Live Weight.	Cost of Food to produce 1 lb. Live Weight Increase.	Cost of Food.	Gain in Live Weight.	Cost of Food to Produce 1 lb. Live Weight Increase.
		s. d.			£ s. d.		
7 weeks	150 lbs.	—	—	—	—	—	—
9 ,,	160 lbs.	7 2	10 lbs.	8.6d.	7 2	10 lbs.	8.6d.
11 ,,	205 lbs.	7 11¼	45 lbs.	2.12d.	15 1¼	55 lbs.	3.29d.
13 ,,	274 lbs.	9 9½	69 lbs.	1.70d.	1 4 10¾	124 lbs.	2.4d.
15 ,,	328 lbs.	11 2¾	54 lbs.	2.5d.	1 16 1½	178 lbs.	2.43d.
17 ,,	387 lbs.	12 10½	59 lbs.	2.62d.	2 9 0	237 lbs.	2.48d.
19 ,,	445 lbs.	15 2½	58 lbs.	3.15d.	3 4 2½	295 lbs.	2.61d.
21 ,,	496 lbs.	17 3½	51 lbs.	4.07d.	4 1 6	346 lbs.	2.82d.
23 ,,	521 lbs.	16 7	25 lbs.	7.56d.	4 18 1	371 lbs.	3.17d.

materially altered. The tables show that the pigs receiving Gram gained in weight at less cost than those receiving Separated Milk, and that the advantage rested with Lot I. throughout the whole sixteen weeks of the experiment; thus at the end of this period the cost of live weight gain in Lot II. was 15.2 per cent. more than that in Lot I. Not only was pork produced at less cost in Lot I., but the average gain in weight of the pigs in the Gram-fed lot exceeded that of Lot II. by over 12 lbs. Not only was the composite group result favourable to the Gram-fed pigs, but an analysis of the complete records shows the superiority to extend to the separate breeds of this group, the half-bred Large White, Middle White, and half-bred Berkshire averaging a 17 lbs., 8 lbs., and 12 lbs. greater gain in live weight respectively than the similarly bred pigs fed on the separated milk ration. A further analysis being extended to the individuals, these can be paired off according to breed to the advantage of Lot 1 in each instance.

This uniformity of results, combined with the cheaper production of pork in the Gram-fed group, gives very decided evidence on the value of this food as an adjunct to Middlings as a food for young pigs. It is to be observed that Gram was fed during the earlier weeks of the trial in amounts approaching the maximum allowance which could safely be fed, and therefore with this food as the only addition to Middlings the pigs were fed for maximum increase. In the case of Lot II., the very moderate daily allowance of 1.25 lbs. of separated milk per pig was less than one quarter the quantity the pig might have consumed. In this experiment the daily gain per animal was .77 lb., while records of experiments where separated milk was allowed *ad. lib.* show average gains of .9 to 1 lb. per day in pigs of similar weight. This experiment was designed primarily to determine the suitability and feeding value of Gram as a supplement to Middlings, and the experiment indicates that Gram has a value for this purpose superior to a diet of apparently similar feeding value composed of Middlings and Separated Milk. In ordinary farm practice the allowance of milk considerably exceeds that fed in this experiment, and the experiment affords no evidence of the superiority or otherwise of the Gram diet fed, over a diet

Table IV.

Lot III.—Feeding: Middlings and Gram.

Age of Pigs.	Weight of Six Pigs.	During Fortnight. Cost of Food.	During Fortnight. Gain in Live Weight.	During Fortnight. Cost of Food to produce 1 lb. Live Weight Increase.	During Period. Cost of Food.	During Period. Gain in Live Weight.	During Period. Cost of Food to Produce 1 lb. Live Weight Increase.
		£ s. d.			£ s. d.		
7 weeks	149 lbs.	—	—	—	—	—	—
9 ,,	163 lbs.	7 2½	14 lbs.	6.18d.	7 2½	14 lbs.	6.18d.
11 ,,	220 lbs.	7 2½	57 lbs.	1.51d.	14 5	71 lbs.	2.43d.
13 ,,	272 lbs.	9 8	52 lbs.	2.23d.	1 4 1	123 lbs.	2.34d.
15 ,,	307 lbs.	11 2½	35 lbs.	3.84d.	1 15 3½	158 lbs.	2.68d.
17 ,,	367 lbs.	12 8½	60 lbs.	2.54d.	2 8 0	218 lbs.	2.64d.
19 ,,	420 lbs.	13 10½	53 lbs.	3.14d.	3 1 10½	271 lbs.	2.74d.
21 ,,	469 lbs.	16 6½	49 lbs.	4.05d.	3 18 5	320 lbs.	2.94d.
23 ,,	501 lbs.	17 11	32 lbs.	6.72	4 16 4	352 lbs.	3.28d.

TABLE V.

LOT IV.—FEEDING: MIDDLINGS AND SEPARATED MILK.

		During Fortnight.			During Period.		
Age of Pigs.	Weight of Six Pigs.	Cost of Food.	Gain in Live Weight.	Cost of Food to Produce 1 lb. Live Weight Increase.	Cost of Food.	Gain in Live Weight.	Cost of Food to Produce 1 lb. Live Weight Increase.
		£ s. d.			£ s. d.		
7 weeks	140 lbs.	—	—	—	—	—	—
9 ,,	151 lbs.	7 7½	11 lbs.	8.3d.	7 7½	11 lbs.	8.3d.
11 ,,	224 lbs.	7 7½	73 lbs.	1.25d.	15 3	84 lbs.	2.18d.
13 ,,	270 lbs.	10 2½	46 lbs.	2.66d.	1 5 5½	130 lbs.	2.35d.
15 ,,	320 lbs.	12 1	50 lbs.	2.9d.	1 17 6½	180 lbs.	2.50d.
17 ,,	378 lbs.	13 6	58 lbs.	2.79d.	2 11 0½	238 lbs.	2.57d.
19 ,,	413 lbs.	15 0	35 lbs.	5.14d.	3 6 0½	273 lbs.	2.9d.
21 ,,	460 lbs.	17 7	47 lbs.	4.48d.	4 3 7½	320 lbs.	3.13d.
23 ,,	486 lbs.	19 1½	26 lbs.	8.82d.	5 2 9	346 lbs.	3.56d.

in which large quantities of separated milk are used. The results however, do prove conclusively that milk is not an essential part of the ration in successful pig rearing, and that Gram used in such quantities as here is a food of considerable economic value.

No difference was detectable in the quality of the pork produced in Lots I. and II.

For Tables IV. and V. see pp. 37 and 38.

Tables IV. and V. are generally confirmatory of the results shown in Tables II. and III. The total gain in weight of the Gram-fed lot is 352 lbs. against 346 lbs. for the more expensively-fed Separated Milk lot, and the advantage of the former over the latter is 8.5 per cent. on the cost of weight production. It will be seen that Lot III. clearly draws ahead of Lot IV. in the cost of live weight increase from the tenth week, while Lot I. held a similar advantage over Lot II. from the fourth week of the trial.

Two breed results in Lots III. and IV. favour the Gram food, while in the third the separated milk food produces better results.

Comparison of Lots I. and II. with the Similarly Fed Lots in Pounds.

It was deemed advisable in forming the groups to arrange the individuals approximately on a weight basis, by which arrangement the changes of food adapted to the average of the group suited also the individual components of the group, and a more even division of the food amongst the individuals was probably secured. Every pig at weaning was thrifty and only in regard to weight were the smaller pigs considered the inferior of the larger ones. The uniformity prevailing in the individual results in each group, and the final superiority of pigs in the indoor groups over pigs initially almost equal in weight and similiarly fed in the pound groups, preclude the possibility of the difference in results of similarly fed but differently housed groups being due to the inherent capacity for growth of the individuals at the commencement of the experiment.

Lots III. and IV. were housed in adjoining pounds, well constructed. The accommodation consisted of a brick-built

sty with a slatted wooden floor on which the pigs rested, abundant litter being provided. An open doorway with a westerly aspect led into a brick-floored open court, in which the troughs were fixed. These conditions were considered favourable, and the poor progress of the pigs must in some measure be attributed to the chilling of the pigs while feeding, and the draughty nature of the inner compartment with the wind in certain directions. A comparison of the similarly fed lots shows that the pound live weight increase was produced at 19.3 per cent. greater cost in Lot III. than in Lot I., and 12.3 per cent. greater in Lot IV. than in the corresponding Lot II. These differences are so very high that the matter of accommodation assumes a position of primary importance in the pig-rearing industry, and particularly so since all the pigs were kept under housing conditions which would be generally approved.

Breed Comparisons.

The data obtained during these experiments enable a comparison to be made on the rate of growth of the three differently bred litters. These are of interest, but afford no conclusive evidence of the superiority of one cross over any other for the production of light porkers, since wide variations occur in the inherited characters of litters from different sows of any breed. The figures given below show the cost of production of the pound increase in live weight, and are obtained from the actual weighings of the individuals and the cost of the food which would have been allotted to the breeds in accordance with Table I. had the pigs been fed individually with rations according to their grouping in the experiment.

Average cost per lb. live weight increase of eight cross Large Whites=2.78d.

Average cost per lb. live weight increase of eight Middle Whites=3.30d.

Average cost per lb. live weight increase of seven cross Berkshires=3.34d.

For Table VI. see p. 41.

Table VI. is compiled from the returns of the cross Middle White—Large White pigs in Lots I. and II., the food here again being that allowed under the scheme of feeding of

TABLE VI.

PIGS:—MID-WHITE—LARGE WHITES IN LOTS I. AND II.

Age.	Combined Weight of Four Pigs.	From Weaning.			From Birth allowing 16s. at time of Weaning.	
		Cost of Food.	Gain in Live Weight.	Cost of Food to Produce 1 lb. Live Weight Gain.	Cost of Pigs to Date, omitting Labour.	Cost per lb. Live Weight.
		£ s. d.			£ s. d.	
7 weeks	131 lbs.	2 10	—	—	3 4 0	5·86d.
10 ,,	171 lbs.	8 4	40 lbs.	2.50d.	3 12 4	5·07d.
11 ,,	208 lbs.	11 5	77 lbs.	1.78d.	3 15 5	4·35d.
12 ,,	230 lbs.	15 1½	99 lbs.	1.83d.	3 19 1½	4·12d.
13 ,,	263 lbs.	19 2	132 lbs.	1.74d.	4 3 2	3·79d.
14 ,,	281 lbs.	1 3 6	150 lbs.	1.87d.	4 7 6	3·73d.
15 ,,	310 lbs.	1 8 0	179 lbs.	1.87d.	4 12 0	3·56d.
16 ,,	331 lbs.	1 12 11½	200 lbs.	1.97d.	4 16 11½	3·51d.
17 ,,	369 lbs.	1 18 4½	238 lbs.	1.93d.	5 2 4½	3·32d.
18 ,,	392 lbs.	2 3 10½	261 lbs.	2.02d.	5 7 10½	3·30d.
19 ,,	415 lbs.	2 10 11½	284 lbs.	2.17d.	5 14 11½	3·32d.
20 ,,	449 lbs.	2 18 2½	318 lbs.	2.19d.	6 2 2½	3·27d.
21 ,,	467 lbs.	3 5 11	336 lbs.	2.35d.	6 9 11	3·33d.
23 ,,	498 lbs.	4 1 5½	367 lbs.	2.66d.	7 5 5½	3·50d.

Table I. In column 5 the cost per pound live weight increases after weaning is given, and the results are in accordance with the the general rule that cost of production advances with age. This increase in cost of production is associated with a decrease in the weight value of the carcase, and so apparently with a diminution in profits as the age of the animal increases. There must necessarily be some weight at which the difference between cost of production and market value of the product is a maximum and this is the time for sale which would leave the greatest margin of profit. Even though the cost of production rises after a certain weight is attained, and the value of the resultant product declines in value, production at a profit may continue for a considerable time and the total profit on the pig will continue to accumulate until the cost of production equals the increase in value of the animal. In theory it is desirable to dispose of the animals about the time the rate of profit declines, and to restock with younger pigs in which the benefit of maximum returns will be obtained. Practical considerations, however, would from time to time occur which would make it advisable for the farmer to retain his pigs beyond the period of cheapest production.

To determine the most profitable time to dispose of the animals the high value of the pig at weaning exerts an influence and delays the best time for sale to a later period than the time of cheapest production of live weight increase for food consumed.

The pigs for which Table IV. is compiled were valued at weaning at 16s. each, which is equivalent to 5.8d. per lb. live weight, and the cost per pound live weight (labour omitted) decreases until the individual weight is about 98 lbs., there are then slight fluctuations until an average weight of 112 lbs. is reached, when a decided rise occurs up to 125 lbs., and figures not given in the table show the rise in cost of production to be progressive with increasing weights. As these changes and a uniform drop in weight value as weight increases are generally concurrent, the cost of production and market value more and more nearly approach one another with time, and the former would ultimately exceed the latter when the feeding would have been done at a loss.

Any alteration in the relative values of sucking pigs and

the cost of foodstuffs would alter the weight at which the cost per unit weight was a minimum, a rise in the former with the latter constant would make a greater weight at sale more profitable, while a relative rise in the price of foodstuffs would make it advisable to dispose of the porkers earlier. Table VI. indicates the weight of maximum rate of profit only for the particular pigs in question, and it is not applicable to other pigs, since breed considerations and individuality must exert a modifying effect, and the table is inserted rather as an indication that a period of maximum profit for weight does actually exist, than to show the exact stage of development of the animal where this is obtained.

Conclusions.

1.—The feeding standards as drawn out in Table I. are sufficient to secure fairly rapid development and the rations allowed in this table satisfy the appetites of the animals.

2.—Half-a-pound per day of Gram meal to newly-weaned pigs is a perfectly safe food. In combination with Middlings it constitutes a good and economic ration, which can confidently be recommended where separated milk is not available.

3.—The system of housing pigs very considerably influences the results obtained, other conditions being similar.

4.—Pigs fed on rations allowed in the experiment can be brought out as porkers of 100 to 110 lbs. live weight at a cost of 3.3d. per lb., newly-weaned pigs of 33 lbs. live weight being valued at 16s. each, and labour, litter and manure being left out of account. Calculating four-score porkers to kill to 75 per cent. their live weight, and valuing such pork at 10s. per score, the value per pound live weight is 4½d., which leaves a substantial profit to the feeder

A NOTE ON THE GROWING OF LINSEED.

By Duncan Davidson, A.R.C.Sc. (Dub.), N.D.A., N.D.D.

Linseed, as the seed of the flax plant is called, is in every-day use on farms as a food for young stock. It is a valuable feeding stuff for "finishing off" show and fat stock, and for entire horses, and is excellent for sick animals. The impure condition of most of the imported linseed is a serious objection to its use as a stock food. Weed seeds, damaged linseed and other refuse are present, often in considerable quantity.

At the present time, when the price is lower than it was in the early part of 1909, a ton of clean linseed will cost £20 delivered at the farm. Linseed meal, which may contain over 10 per cent. of other meal, will cost £22 a ton. Owing to the increasing demand for linseed oil and the uncertainty of foreign supplies, a rapid return to the high prices which obtained during the period extending from October, 1909, to June, 1912, is not improbable.

The oil from English and Continental linseed is preferred by the trade to that from linseed grown in India, Argentina, the United States and Algeria. This preference, together with the growing demand for linseed oil, and the fact that recent improvements in machinery make it quite probable that linseed straw will be utilised as a source of fibre or for paper-making, opens up a prospect of growing linseed on a commercial scale.

The farmer who produces his own linseed secures a clean product of better quality than the average imported linseed, and he is unaffected by rising prices. Moreover, he is gaining knowledge of a crop which is not without possibilities in the near future, should the present increase in the demand for linseed oil continue.

The requirements of the linseed crop are practically unknown in the United Kingdom. The growing of flax for fibre has been a feature of Irish and, to a less extent, of British agriculture for many years, but the area now under flax is much less than that which was devoted to the crop half a century ago. To obtain fibre of high quality the crop must be harvested before the linseed is ripe. On the Continent the unripe seed is removed, and forms the bulk of the linseed exported, while in Ireland practically no attempt is made to save the seed.

In the early eighties a comparatively large area of flax was grown in Monmouthshire as an experiment for paper-making, and here and there throughout the country attempts have been made to grow linseed on a small scale. Notwithstanding that during the last three years small areas of linseed have been grown in North Wales, Essex, Kent and other places, with considerable success, the limited experience and want of data in regard to linseed growing make further investigation an urgent necessity.

As to climate, in India, Argentina and the United States, a warm rainy season is, as a rule, followed by a dry, hot, sunny, ripening period: in Russia and Holland a cooler, moister and less certain climate, more like that of England, prevails. But in the former countries flax is grown as a seed crop, whereas on the continent the production of fibre is the chief object.

The most suitable soil for linseed growing is not yet determined. Like barley, it appears to favour calcareous soils, clay and peaty soils being unsuitable. All warm, fairly deep, free working soils may be expected to produce a good linseed crop if a suitable variety is grown. This question of variety is a very important one, and the selection of varieties suitable for growth in England is essential.

The climate and soil of the south-east of England would appear to be better adapted for linseed growing than that of the northern and western parts of the country. The average annual rainfall—twenty-six inches—is lower, the late summer is drier and warmer, and the calcareous loams on the lower slopes of the Downs and the alluvial soils in the valleys are apparently more suitable.

As a preliminary experiment, a quarter of an acre of linseed was grown in 1912 to obtain some first-hand information as to the cultivation, harvesting, cost of production and probable yield of the crop. The soil, a fairly deep medium loam, was in good heart and clean. After removing early potatoes and a following cauliflower crop, 22 tons of dung were ploughed down in the autumn of 1910, a crop of tobacco was taken in 1911, and the land was ploughed deeply in the following winter. In May, 1912, two heavy harrowings reduced the well weathered furrows to a fine tilth. Potassium sulphate at the rate of one cwt. per acre was harrowed in. On May 15th the land was rolled and the seed, kindly supplied by the Irish Department of Agriculture, was sown with a grass seed barrow, at the rate of two bushels to the acre, on the rolled surface. A light harrowing covered the seed to a depth of half an inch, and immediately after the land was lightly rolled.

During April practically no rain fell, and May being a very dry month, the seed did not braird for three weeks. June, with its warm rains, induced rapid growth, and at the end of July the plants were about three feet three inches high, but they did not branch so extensively as is necessary for a heavy seed yield. The fairly high condition of the soil, the thick seeding, and the variety grown—a fibre strain—all tended to produce tall stems, free from branches. The somewhat late sowing proved an advantage as growth was not too far advanced when August set in, with cold, wet weather. The crop was harvested during the first fortnight in September. The heavy rains washed and weakened the straw, which lodged to some extent, and it was necessary to cut the crop with the scythe. The sheaves were tied with binder twine and only a little seed was lost in handling the crop on the field.

The ordinary threshing machine does not remove all the seed even when the straw is put through a second time, and in the absence of suitable machinery the seed was beaten out with a flail. It was, however, not possible to thresh out all the seed by this method. The linseed was cleaned with a winnowing machine, but special screens are required to do this work rapidly and thoroughly.

The yield of linseed, containing a little over 40 per cent. of

oil, was at the rate of 18 bushels of 56 lb. per acre. The linseed, chaff and straw were used on the College farm.

The limited data available and the necessity for further inquiry in connection with the growing of linseed make a detailed estimate of the cost of production per acre impossible at this stage, but it may be taken that the amount is within £6 per acre on clean, free working land.

The yield and quality of the linseed, having regard to the inclement ripening and harvesting weather, were satisfactory, and experiments to determine whether linseed can be grown profitably in the south-east of England as compared with other parts of the country will be carried out in 1913. It was thought advisable, however, to place on record this note on the preliminary trial.

I have to thank my colleague, Mr. T. E. W. Dobson, for advice and ready assistance during the progress of the experimental work.

COUNTY AGRICULTURAL WORK.

By G. H. Garrad, N.D.A.

The appointment of an Agricultural Adviser, whose duties should be devoted entirely to work outside the College, was made in November, 1912, so that this report deals only with six months work, from November, 1912, to May, 1913. The work which has been carried out during this period may be divided up under the following headings :—

1. Lecture Work.
2. Short Courses for Farmers' Sons at the College.
3. Replies to Enquiries.
4. Visits to Farmers.
5. Field Experiments.
6. Milk-recording Scheme.

1.—Lecture Work.

During the winter 42 Lectures have been given at various centres in different parts of Kent and Surrey, the total attendance being 739, or an average of 17 persons per lecture. These figures do not include six lectures given on Manures by Mr. Edwardes-Ker, two each at Bethersden, Ash-next-Sandwich, and Langley, nor, of course, the lectures given on Fruit Growing, Entomology, Mycology, etc., by other members of the College Staff. The complete series of Lectures given are tabulated below :—

Lectures on Agricultural Subjects.

Centre.	Subject.	No. of Lectures.	Total Attendance.
Lingfield	.. Soils and Manures ..	5	58
Chobham	.. Manuring ..	1	6

Centre.	Subject.	No. of Lectures.	Total Attendance.
Chobham	.. Intensive Cultivation ..	1	14
,,	.. Weeds ..	1	4
Reigate	.. Pig Keeping ..	1	35
,,	.. Cows ..	1	29
Great Chart	.. Soils and Plant Growth ..	1	25
,,	.. Improvement of Grass Land	1	28
,,	.. Feeding of Farm Stock ..	2	57
Hastings	.. Feeding of Dairy Cows ..	1	26
Bethersden	.. Soils ..	2	23
Tunbridge Wells	Feeding Stuffs ..	1	16
Robertsbridge	.. Manures ..	1	20
Langley	.. Soils ..	2	30
Egerton	.. Farm Crops ..	4	40
Hoo	.. Farm Crops ..	4	42
Marden	.. Tobacco Culture ..	1	40
High Halden	.. Manures ..	1	18
Sellindge	.. Foods and Feeding ..	4	59
Mersham	.. Manuring ..	1	18
Ash-next-Sandwich	.. Soils ..	2	31
Cudham	.. Soils and Manures ..	2	60
Hartlip	.. Soils ..	1	30
Rye	.. Home-grown Foodstuffs ..	1	30
	Totals ..	42	739

Average Attendance per lecture .. 17.

2.—Short Courses for Farmers' Sons.

The first Course was held from April 9th to May 1st. Thirty-four Students attended—thirty-two from Kent, one from Surrey and one from Essex. Four courses of ten lectures each were given by Mr. J. Mackintosh on "Agriculture," the subjects being "Soils and Manures," "Farm Crops," "Foods and Feeding" and "Dairying." Dr. S. J. M. Auld gave a course of ten lectures on "Chemistry," and Prof. T. W. Cave twelve lectures of an hour-and-a-half each on "Veterinary Science." Ten classes in "Farm Book-keeping" were taken

by Mr. A. H. J. Haines, and ten lectures on "Insects and Fungi" by Mr. G. H. Garrad. Mr. H. P. Hutchinson gave a course of ten lectures accompanied by practical work on "Grasses and Clovers."

Three lectures were given each morning from 9.30 to 12.30, two each afternoon from 2.30 to 4.30 and one every evening from 6.30 to 7.30. Saturdays were observed as half-holidays. Such hours as were available were utilized by the students for journeyings over the College Farm, and on one afternoon a demonstration was given of the Aspinwall Potato Planter at work.

A second course was held in the Christmas vacation, from December 30th, 1912, to January 12th, 1913. The attendance was smaller than at the first one, sixteen students attending from Kent and three from Surrey, and the course was of shorter duration. Lectures were given as before on "Veterinary Science," "Grasses and Clovers," and "Book-keeping," by Prof. T. W. Cave, Mr. H. P. Hutchinson and Mr. A. H. J. Haines respectively, but in the case of the other courses the lecturers were changed, Mr. C. Hutchinson taking "Foods and Feeding," and Mr. G. H. Garrad "Soils and Manures." Six lectures a day were considered to be too much for men who were accustomed more to outdoor work than to indoor study, so on this occasion only five lectures were given each day, one being cut out in the afternoon. The Students thus had two hours every afternoon for visiting the Farm and other departments of the College.

3. Replies to Enquiries.

The Agricultural Adviser has sent out 476 replies to enquiries received during the last six months, enquiries ranging over the following subjects: Soil Analysis, Manuring of Roots, Cereals and Grass (particularly with regard to the use of basic slag, compound manures, mixing manures, use of nitrolim and nitrate of lime), Ensilage Manufacture and Use, Varieties of Lucerne, Varieties of Wheat, Mangels, Eradication of Dodder, Potato Spraying, Tobacco Growing, Foodstuffs and the Compounding of Rations, Value of Compound Cakes and Meals, Bastol, Maize Feeding for Pigs.

4. Visits to Farmers.

Forty-one visits have been paid to farms to investigate the conditions under which some of the subjects of enquiries occurred, and field experiments were carried out at several centres in order to arrive at a satisfactory conclusion on the farms.

6.—The Milk Recording Scheme.

This scheme at the time of writing embraces a circuit of nineteen farmers who are visited regularly once a month by Mr. Chandler, the College Recorder, and a smaller circuit of five farms in Sussex, which is being worked at more frequent intervals by another old student, Mr. Burke, whose expenses are being paid entirely by the owner of the farms.

Each farmer in the scheme provides himself with a milk-weighing outfit (dial, pail and tripod), and undertakes to weigh the milk of all the cows in the herd on one morning and one evening in each week. A Weekly Record pad, a copy of which is appended, is supplied by the College for this purpose and hung up in each cow shed.

WEEKLY MILK RECORD IN LBS.

Month—January.

No. of Cow—		1	2	3	4	5	6	etc.
1st Week	Morn.							
Date Jan. 5th	Even.							
2nd Week	Morn.							
Date Jan. 12th	Even.							
etc., etc.								

The College Recorder, at his monthly visit, arrives at every farm in time for the afternoon milking, and weighs the milk from each cow, evening and morning, during the day he is on the farm. He also examines the figures for the weekly weighings and forwards duplicate sheets of the same to the College. At the College the weekly weighings from each cow are entered in a book and at the end of the year these are totalled up and a statement of the Milk Yield of every cow in his herd forwarded to each farmer as under :—

Milk Records for Mr. Brown's Herd.

January, 1912, to January, 1913.

No. and Name of Calf.	Weeks in Milk.	Gallons Milk.	Weeks Dry.	Weeks in Milk.	Gallons Milk.	Total Weeks in Milk.	Total Gallons Milk.	Percentage Fat.
1st Calf Cows.	1st Lactation Period.			2nd Lactation Period.				
12. Rose.	19	214	11	22	314	41	528	3·9
15. Tulip.	Calved March 29th.		13	39	708	39	708	3·3
18. Flower.	10	105	Still in Milk.			10	105	3·4
2nd Calf Cows.	2nd Lactation Period.			3rd Lactation Period.				
6. Crocus.	26	287	9	17	318	43	605	3·6
13. Daisy.	17	250	Sold.			17	250	3·1
29. Bluebell.	39	538	5	8	152	47	690	3·4
		etc.,	etc.					

At each visit the Recorder also obtains a statement of the food given per day or per week, with the prices of the purchased foods and weighs the exact quantities that are being fed. This "Food Record" is then forwarded, together with the "Milk Record," after each visit, to the College, where a statement of the daily cost of food per cow, the cost of food per gallon of milk and the composition of the ration is worked out and returned to the farmer in the following form :—

WYE COLLEGE MILK INVESTIGATION.

Fourth Visit to Mr. Robinson's Farm.

Date, April 2nd, 1913.

No of Cows in Milk, 43.

Day's Yield of Milk: Morning $63\frac{1}{2}$ Gallons, Evening $36\frac{1}{2}$ Gallons ; Total 100 Gallons.

Average Yield per Cow: 1,026 lbs. Milk, ÷ 43 Cows = 23.86 lbs. Milk.

Amount, Cost and Composition of Ration.

	Price per Ton.	Cost per Day. Pence.	Dig. Protein. lbs.	Starch Equiv. lbs.
73 lbs. Mangels ..	10/-	3.91	.36	5.11
$8\frac{1}{2}$ lbs. Hay ..	60/-	2.70	.33	2.60
6 lbs. Oat Straw ..	40/-	1.28	.06	1.14
17 lbs. Wet Grains ..	17/-	1.55	.68	2.56
$2\frac{1}{4}$ lbs. Linseed Cake ..	170/-	2.00	.55	1.67
1 lb. Undec. Cotton Cake..	120/-	.71	.16	.44
1 lb. Gluten Feed ..	140/-	.82	.23	.81
$1\frac{1}{4}$ lbs. Middlings ..	130/-	.90	.15	.96
Totals ..	——	13.87d.	2.52lbs.	15.29lb.

Ratio .1 of Dig. Protein to 6.1 of Starch Equiv.

	Dig. Protein. lbs.	Starch Equiv. lbs.
* **Theoretical Requirements:**		
Maintenance Ration (1,200 lbs. Cows)	.84	7.2
Production Ration (2.3 Galls. Milk)	1.17	5.8
Totals	2.01 lbs.	13.0 lbs.

Ratio .1 of Dig. Protein to 6.4 of Starch Equiv.

		Average of all Farms last Month.
Average Daily Yield per Cow	23.86lbs.	22.55lbs.
Average Daily Cost of Ration	13.87d.	13.75d.
Average Cost of Food per Gallon	5.96d.	6.38d.

Composition of Milk: Morning, 3.5 per cent. Fat.
Evening, 4.1 per cent. Fat.

Remarks: The ration is well balanced and appears to be liberal. According to the Theoretical Requirements of the Cows the ration might be reduced slightly without any deleterious effect.

During the summer, when the cows are out to grass, only the artificial foods fed are put down in the ration and the cost of the ration at each visit is not worked out. At the end of the summer the acreage of the grass grazed by the cows and any other green food which they may have had is valued by the farmer himself, with the assistance of the College Recorder, and added to the artificial food. The total cost divided by the number of gallons yielded by the cows during the time they were out to grass will then give the cost of food per gallon of milk.

In last year's scheme the milk from each cow in the various herds was sampled by the Recorder at each visit, and sent to the College for Fat determination. It was found, however, that this involved considerable time and expense, and as the farmers concerned were not much interested in the quality of their milk, this part of the scheme has now been abandoned. Farmers can, if they like, have it done by paying at the rate of 1½d. per sample tested, but only three farmers out of the

* "Winter Feeding of Dairy Cows," by Jas. Mackintosh. Copies obtainable from the Secretary of the College, 3d. by residents in Kent or Surrey; non-residents, 6d.

nineteen consider it worth their while to have it done. All of them have composite samples taken once a month of the milk of the whole herd, and these are tested at a charge of 1d. per sample.

The above is a general outline of the scheme as it stands at present. No grant is as yet obtainable from the Board of Agriculture for the work, so that the cost has to be kept down as far as possible. A share of the expense is paid by the farmer and the rest is paid by the College. The farmer, when he joins the scheme, undertakes three things :

1.—To afford the Recorder board and lodging for one night each month.

2.—To agree to subscribe at the rate of 1s. per cow per annum towards the cost of the scheme ; the number of cows on which payment is made to be the average number in the milking herd during the first six months, and cheques and money orders to be forwarded to the College before the end of the ninth month.

3.—First cost of the weighing outfit (dial, pail and tripod, 45s.).

The total cost of a year's work is estimated at £150 to £160. Nineteen farmers represent 700 to 750 cows, hence the amount contributed on the above basis is £35 to £38, or about one quarter of the total cost. All printing is met by the College, as well as the salary and travelling expenses of the Recorder.

The main object of the scheme is, of course, to encourage farmers in the keeping of Records so that they may know the exact quantity of milk produced and food consumed by their cows, also which cows are paying for their keep. There is no need to go into the value of such records here. But the figures are equally valuable to the College in its investigations into the cost of food in the production of milk under different systems of feeding. One report on the cost of food in the production of milk has already been published,* and another is in course of preparation. The mass of information which is accumulating monthly is likely to be of very considerable

* First Report on the Cost of Food in the Production of Milk. Copies obtainable from the Secretary of the College, 3d., by residents in Kent or Surrey; non-residents, 6d.

value in devising a system of feeding which will lower the cost of production of milk. One system has already been suggested in Mr. Mackintosh's article on the Winter-feeding of Dairy Cows (see page 57 in this *Journal*), which was first published as a College leaflet last autumn, and that system is being thoroughly tested each month as our returns from each farmer come in, so far with very satisfactory results.

Any farmers in Kent or Surrey who would like to join this Milk-Recording Scheme next January are asked to write and let the College know as soon as possible, as only a limited number of farms can be worked by one Recorder. It is noteworthy that during the winter two farmers have written to ask if there was at the College any student who had finished his course who would be willing, for his board and lodging and to gain experience in practical farming, to keep their Milk Records for them. This is at least a sign that farmers are waking up to the value of the scheme. One farmer was supplied with a student, and when the writer visited him six weeks ago he was informed that quite a considerable saving had already, through a knowledge of the exact amount of food that was being fed, been effected in his cost of production of milk. The same farmer has written within the last week to say that he is now investing in a Gerber Tester for the analysis of his milk.

WINTER FEEDING OF DAIRY COWS.

By James Mackintosh N.D.A. (Hons.), N.D.D.

PART I.

In any discussion on the feeding of dairy cows or other animals it is first of all necessary to understand the nature and use of the various feeding stuffs. These will be considered briefly under the following heads :—

1. The constituents of foods.
2. The function of these constituents.
3. The utilization of the food by the animal.

1. Constituents of Foods.

The agricultural chemist classifies the constituents of foods under the following names :—

Protein or Albuminoids.	Fibre.
Fat or Oil.	Ash or Mineral Matter.
Carbohydrates (Starch, Sugar, etc.).	Water.

Almost all the foods in ordinary use contain all the above substances in varying quantities, and the importance of two of these—the protein and the fat—is recognised and emphasized by the Fertilizers and Feeding Stuffs Act, which gives the buyer power to demand a statement of the percentage of each in any purchased food to within stated limits of error—such statements on an invoice to be recognised as a guarantee.

Foods are generally classified according to the relative proportions of the above constituents which they contain. Those with a high percentage of protein, oil and carbohydrates are usually described as *Concentrated Foods*, *e.g.*, linseed cake, cotton cake, maize, etc., and those with a large proportion of fibre or water are described as *Bulky Foods*, *e.g.*, hay, straw, roots.

Digestible Constituents.—The ordinary statement of the percentage of the foregoing substances present in any food does not afford an accurate measure of its value to an animal as no mention is made of *digestibility*, and only those portions,

of a food which are digested can be utilized by the animal. Many tables of compositions have been prepared which show both the percentage of *total* constituents and the percentage considered to be *digestible*; one of these is included in table facing page 66, and a study of the two sets of figures is essential to a working understanding of the scientific feeding of animals. It must be kept in mind that the Fertilizers and Feeding Stuffs Act only stipulates for a statement on the invoice of the *total* albuminoids (protein) and oil, not the *digestible* percentages.

The protein, oil and carbohydrates in the concentrated foods are almost entirely digested, but there are exceptions, as in the case of the protein in malt culms, where there is a 50 per cent. difference due to the fact that the total percentage of protein (or crude protein) contains a large proportion of substances known as amides, which are of much less use to the animal, and therefore the percentage of digestible true protein is greatly reduced. The oil is the most completely digested of all the food constituents, and the carbohydrates are likewise largely digested in those foods containing large amounts of starch and sugar, *e.g.*, maize meal, and locust beans, but much less so in foods containing large quantities of crude fibre, *e.g.*, undecorticated cotton cake, hay, straw. The proportion of the fibre itself which is digested is very variable according to the kind of food, *e.g.*, fibre in meadow hay is much more digestible than the fibre in lucerne hay or in straw. In tables of digestible constituents it is customary to add the percentage of digestible carbohydrates and digestible fibre together and state the total in one column (see table facing page 66).

CONDITIONS AFFECTING DIGESTIBILITY.—Many methods of preparing foods are largely advocated because they are said to increase the digestibility; this is the case in the grinding of cereal grains into meal, but the effect of cooking, steaming, fermenting, etc., has been frequently over-estimated. Such processes make foods more palatable to the animal than they would otherwise be, and this may aid digestion somewhat, but the universal effect of cooking is to make the protein less digestible, hence foods with a fair percentage of this constituent should not be cooked. Very starchy

foods may be improved by grinding and cooking, as the starch grains are then more easily acted on by the digestive juices, but the cost is likewise increased above that of the raw product. Where it is desirable or necessary to feed quantities of inferior fodder, chopping, steaming, admixture with sugar foods or spices may be resorted to, but again the effect is more in making the food appetising than in increasing its digestibility.

2. Function of the Food Constituents.

The *protein* in the food is used to form muscle, etc., in the animal body, and is frequently described as the "flesh-forming" portion of the food. It may also serve as a fat-forming substance, and as a source of heat and energy, but for these purposes it is less effective and more costly than the fat or carbohydrates.

In milk-producing animals the protein in the food has also to keep up the supply of raw material for the protein in the milk, of which there is usually 3 to 4 per cent. While protein can replace the fat and carbohydrates for the production of body fat and heat, it is most important to remember that the fat and carbohydrates cannot replace the protein in the formation of muscle, etc., or as the sources of the protein in the milk; hence rations for all animals must contain enough of this constituent to supply the needs of the animal body.

The *fat, carbohydrates* and *digestible fibre* are utilized for the production of heat, energy and body fat, and in milking cows as a source of the fat and milk sugar in the milk. It has been definitely proved that the percentage of fat in the milk is in no way related to the percentage of fat in the food; also that milk fat is largely formed in the milk-producing glands from the carbohydrates supplied in the food. While the fat and carbohydrates are both utilized for the production of body fat and heat, it has been found that, weight for weight, the fat is much more effective, *i.e.*, 1 lb. fat has as much value to the animal as $2\frac{1}{4}$ lbs. carbohydrates.*

* It should be kept in mind that the names protein, fat, etc., do not refer to definite substances of known composition, but rather that each name covers a number of similar compounds differing somewhat in composition and effect, *e.g.*, the protein in wheat is different from the protein in maize, and the oil in rice meal is most likely inferior in feeding value to the oil in linseed cake.

The *ash* or *mineral matter* in the food is required to form bone, especially in growing stock, and dairy cows have greater need of foods containing a due proportion of mineral matter than is the case with other full grown stock, as the milk produced must supply the bone-forming material to young animals until the latter are old enough to eat other foods. In practice the amount of ash in the ration does not require attention, as almost any ordinary mixture of foods will contain enough for the cow's own needs as well as for milk production. Maize products, locust beans and molasses of the common foods, however, require mention as being notably low in bone-forming matter.

VALUATION OF FOOD CONSTITUENTS.—Many attempts have been made to find a method by which the feeding value of the protein, fat, etc., in any food could be calculated and expressed in a simple form, which could be utilized for purposes of comparison, or for stating the quantity to be allowed per day to any animal. Such attempts have usually taken the form of stating the value of the constituents of any food in units of heat, as their capacity for producing heat is a quality common to all of them; later exhaustive investigations by the German agricultural chemist Kellner, have resulted in the adoption of what is known as the "starch equivalent" method of valuation. This method states the value of any food or ration in terms of starch, so that if the starch equivalent (or value) of decorticated cotton cake is stated to be 71, it means that for production purposes 100 lbs. of the cake are equal to 71 lbs. of starch. A column of starch values (or units per 100 lbs.) of the commoner foods will be found in table facing page 66. It is also possible to calculate the starch value of any given food from the analysis, but the calculation is one that is not likely to be made by a practical man when the table of starch values is already provided.

Although this method affords a means of comparing the feeding values of foods, it does not enable one to state the quantity of food required per day by an animal in a single expression. The imperative necessity for a certain amount of protein in any ration has already been emphasized, and precautions must be taken to ensure a sufficient supply of this constituent. If we suppose that an animal requires 6 lbs.

starch equivalent per day, this quantity could be supplied by such foods as locust beans and treacle, but these foods contain practically no protein and the animal would soon become ill. A statement of the amount of food required daily by an animal must therefore be *so many* lbs. starch equivalent *containing so many* lbs. protein.

3. The Utilization of the Food.

At the present time the accepted method of explaining the utilization of food is to state that it is used for two purposes:—

(*a*) For maintenance.
(*b*) For production.

(*a*) The proportion of a ration used for maintenance is the amount required to keep the animal in a healthy active condition without causing either a gain or loss in live weight, and a ration which accomplishes this end is known as a *maintenance ration.*

(*b*) The proportion of a ration used for productive purposes is that supplied over and above the maintenance requirements, and this may be utilized in the following ways: (1) for growth in the case of young animals; (2) for the production of fat; (3) for the production of milk; (4) for the growth of the offspring before birth; (5) for draught in the case of horses. In the case of the dairy cow the productive portion of a ration should be used chiefly for milk production, to a less degree for the growth of the unborn calf, and only when a cow is near the end of a lactation, is dry or barren, for the production of body fat. It is the inherent capacity to utilise the food for milk production rather than for fattening, that constitutes the true difference between the dairy type and the beef type of cow, whatever be the external characteristics of shape, style of udder or handling properties.

FEEDING STANDARDS.—Many attempts have been made by scientific investigators on the continent and in America to state with reasonable accuracy the quantities of digestible protein, oil and carbohydrates which should constitute a maintenance diet for cows of a definite live weight, and likewise the additional quantities required for the production of definite amounts of milk.

A comparison of the standards recommended by the various investigators shows a distinct uniformity in the quantity of protein suggested, but further comparison is made difficult by reason of the different terms used to indicate the other constituents. Reference has already been made to the *starch equivalent* of Kellner; Armsby, the leading American expert uses the word *therm,* while Hansson, of Sweden, employs the rather vague name of *food unit.* In the standards suggested by these authorities (see Table I.) these terms—starch equivalent, therm and food unit—include all three food constituents, and in addition, the amount of digestible protein is stated separately, so as to ensure a sufficient supply of that ingredient.

TABLE I.

QUANTITY OF FOOD CONSTITUENTS RECOMMENDED FOR MAINTENANCE.

Maintenance Standards for Cows of 1,000 lbs. live weight (9 cwt.).

Authority.	Condition of animal.	Standard.
Kellner ..	Cow—dry, in calf ..	6 lbs. Starch equiv., containing ·75 lbs. Protein.
Armsby ..	Cow—dry ..	6 Therms, containing ·50 lbs. Protein.
Hansson ..	Cow—dry ..	6·6 Food Units, containing ·65 lbs. Protein.

Besides the above, Haecker, of the Minnesota Agricultural College, whose work is greatly appreciated by the farmers in the State, has formulated a standard in terms of protein, fat and carbohydrates, basing his quantities on the *total* percentages of these substances—not the digestible, as in the three previous cases. Haecker's standard for a dry cow is ·7 lbs. protein, ·1 lb. fat and 7·0 lbs. carbohydrates per 1,000 lbs. live weight.

The foregoing standards have been so carefully worked out from experimental results, and tested practically on a large scale, especially in Sweden, Denmark and the United States, and the general agreement between the recommenda-

tions is so marked, that they may be taken as forming a sound basis on which to build a science of feeding.

As a dairy cow under ordinary conditions is producing milk or carrying a calf, and often both, it is obvious that a slightly larger quantity of food should be allowed than in the case of a dry cow not in calf, and after a full consideration of the conditions affecting cows the following standard is suggested as suitable for a dry cow in calf under ordinary English conditions. Live weight 1,000 lbs. (9 cwts.).

Starch Equivalent.	Dig. Protein.	Dig. Oil.	Dig. Carbohydrates and Fibre.	Dry Matter.
6·0 lbs.	·70 lbs.	·10 lbs.	9·0 lbs.	20 lbs.

QUANTITY OF FOOD REQUIRED FOR PRODUCTION.

As milk is the most important product from a dairy cow, the extra food required is usually stated in relationship to 1 lb. or to 10 lbs. of milk. The American experts referred to above do not rest content with a ratio between food and quantity of milk only, but give standards for milk of varying quality based on the percentage of butter-fat present. Haecker lays special stress on this point of view as milk rich in fat is likewise above the average in milk protein and milk sugar.

TABLE II.

QUANTITY OF FOOD CONSTITUENTS RECOMMENDED FOR MILK PRODUCTION IN ADDITION TO MAINTENANCE ALLOWANCE.

Authority.	Quantity of Milk.	Standard.
Kellner ..	for each 10 lbs. Milk given ..	2·0-2·7 lbs. Starch equiv. containing ·55-·65 lbs. Dig. Protein.
Armsby ..	Ditto (4% fat) ..	3·0 Therms, containing ·50 lbs. Dig. Protein.
Hansson ..	Ditto ..	3·3 Food Units, containing ·45-·5 lbs. Dig. Protein.
Haecker ..	Ditto (4% fat) ..	2·7 lbs. non-Protein Foods, plus ·47 lbs. Crude Protein.

As in the case of the standards for maintenance, the quantities of protein recommended by the various authorities are in close agreement, and a practical average for English conditions may be suggested as follows: *for every gallon of milk yielded give food supplying 2.5 lbs. starch equivalent containing .5 lbs. digestible protein.*

The quantities recommended for maintenance are for animals of 1,000 lbs. live weight (9 cwt), and with larger animals the amount is increased in proportion to the increase in live weight, thus for a cow of 1,200 lbs. (10¾ cwt.) the allowance would be 7.2 lbs. starch equivalent containing .84 lbs. protein. In the quantities recommended for milk production the basis is quantity of milk produced, hence there is no increase according to the live weight of the cow; it is taken that, provided the maintenance allowance is increased according to weight, the same amount of food is necessary for the production of the same amount of milk in a cow of 1,000 lbs. as in one of 1,200 lbs.

The theoretical recommendations may now be summarized, using Kellner's starch equivalent method of stating the necessary standards, as that is probably the most correct and the best known in this country.

Table III.

Quantities of Food Constituents recommended for Cows under English Conditions.

	1,000 lbs. Live Weight.		1,200 lbs. Live Weight.	
	Starch Equiv. lbs.	containing Protein. lbs.	Starch Equiv. lbs.	containing Protein. lbs.
For Maintenance (Dry Cow in Calf)	6·0	·70	7·2	·84
For Production (Per Gallon of Milk) ..	2·5	·50	2·5	·50

These recommendations are amplified in the following table, which gives the amounts for cows of different weights and yielding varying quantities of milk per day.

Table IV.

Quantity of Food Constituents Recommended for Maintenance and Milk Production.

Live Weight.		2 Galls. per day.		3 Galls. per day.		4 Galls. per day.		5 Galls. per day.	
		St. Equiv. lbs.	Protein. lbs.	St. Equiv. lbs.	Protein. lbs.	St. Equiv. lbs.	Protein. lbs.	St. Equiv. lbs.	Protein. lbs.
1,000 lbs. or	Maintenance ..	6·0	·70	6·0	·70	6·0	·70	6·0	·70
9 cwt.	Production ..	5·0	1·00	7·5	1·50	10·0	2·00	13·5	2·50
	Total ..	11·0	1·70	13·5	2·20	16·0	2·70	19·5	3·20
1,200 lbs. or	Maintenance ..	7·2	·84	7·2	·84	7·2	·84	7·2	·84
10½ to 11 cwt.	Production ..	5·0	1·00	7·5	1·50	10·0	2·00	13·5	2·50
	Total ..	12·2	1·84	14·7	2·34	17·2	2·84	20·7	3·34
1,400 lbs. or	Maintenance ..	8·4	·98	8·4	·98	8·4	·98	8·4	·98
12½ cwt.	Production ..	5·0	1·00	7·5	1·50	10·0	2·00	13·5	2·50
	Total ..	13·4	1·98	15·9	2·48	18·4	2·98	21·9	3·48

PART II.

The foregoing pages have been devoted to a statement of the theory of feeding dairy cows, and to an explanation and summary of feeding standards for maintenance and production. It is now necessary to show how these scientific recommendations may be translated into practice, and to discuss certain other aspects of the practical feeding of cows which have not yet been touched on.

Selection of Rations—General Principles.

The principles underlying the selection of rations involve a consideration of the following points.

1. QUANTITY OF FOOD.—This is usually stated in lbs. of dry matter, but as the amount may vary within wide limits, and practically all rations contain enough, no further discussion is necessary.

2. PROPORTIONS OF STARCH EQUIVALENT AND PROTEIN.—This will be exemplified in the rations suggested on the following pages, and where these are adopted no calculation on the part of the farmer is necessary. It may be mentioned, however, that a statement of starch equivalent and protein in a ration includes all the information that was formerly conveyed by the term albuminoid or nutritive ratio.

3. PALATABILITY.—This quality is never represented by the chemical analysis of a food, but it is of fundamental importance. It is essential that the foods provided should be fresh and appetising, and it may also be kept in mind that animals may refuse new foods simply because they are new, not because they are unpalatable. Steaming, fermenting, mixing with spice or treacle are often valuable aids in making inferior fodder appetising, and a mixture of two or more concentrated foods is usually more acceptable than a single food.

4. EFFECT ON PRODUCE.—Certain foods, *e.g.*, turnips, swedes, cabbage, silage, if fed to cows before milking give milk

COMPOSITION OF FEEDING STUFFS.

	Total Dry Matter.	PERCENTAGE OF CONSTITUENTS. Total. Protein.	Total. Oil.	Total. Carbo-hydrates.	Total. Fibre.	Digestible. Protein.	Digestible. Oil.	Digestible. Carbo-hydrates and Fibre.	Starch Equivalent per 100 lb.
	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent	Per cent.	lbs.
Cottonseed Cake—									
Decorticated	92	41	9	26	8	34	8½	20	71
Undecorticated Egyptian ..	88	22	5½	34	20	15½	5¼	20	40
" Bombay ..	88	20	4½	35	22	14	4	21	37
Linseed Cake	88	30	10	34	9	25	9½	32	76
Cocoanut Cake	89	22	10	36	15	17	9½	39	78
Soya Bean Cake	88	43	6	28	5	34	5½	22	67
Soya Bean Meal (extracted) ..	88	—	—	—	—	36	1¾	24	61
Soya Beans	89	36	17	26	5	28½	15½	20	82
Linseed	91	23	36	23	6	17	34	21	119
Maize Gluten Meal	90	38	4	45	2	33	3½	42	77
Maize Gluten Feed	90	26	3	53	6	21	2½	52	74
Maize Germ Meal	90	—	—	—	—	8½	10½	55	85
Wheat Middlings	88	15	3½	62	5	12	3	56	74
Wheat Sharps	88	15	4½	57	8	11	3½	50	58
Wheat Bran (coarse)	87	14	4	56	9	10	3	45	47
Malt Culms or Coombs	90	23½	2	44	12½	11½	1½	39	40
Brewers' Grains dried	91	20	6	43	16	14	5	35	50
" " wet (fresh) ..	24	5½	2	12	4½	4	1¼	10	15
Rice Meal	90	12	12	50	8	6	10	42	70
Locust Bean Meal	86	6	1½	70	6	3½	1	70	73
Treacle or Molasses	78	10	—	60	—	—	—	55	48
Wheat	87	12	2	69	2	9	1¼	65	73
Barley	86	10	2	67	5	9	1¾	64	74
Oats	87	12	6	55	10	9	5¼	45	63
Maize	89	10½	5	70	2	7	4½	68	84
Beans	86	25	1½	48	7	19	1¼	48	67
Peas	86	23	1½	54	6	17	1	53	70
Meadow Hay (medium quality) ..	86	10	2½	42	26	4	1	41	31
Clover Hay " "	84	13	2½	37	25	5½	1½	38	31
Straw—Wheat	86	3	1¼	37	40	¼	½	34	12
" Barley	86	3½	1½	38	38	¾	½	40	19
" Oat	86	3½	2	38	37	1	½	39	19
" Bean	82	8	1	31	36	3¼	½	36	19
" Pea	86	9	1½	34	35	3½	¾	32	15
Mangels	12	1¼	¼	9	1	½	$\frac{1}{10}$	9	7
Swedes	11½	1¼	¼	8	1½	½	$\frac{1}{10}$	8	7
Turnips	9½	1	¼	6	1	½	$\frac{1}{10}$	6	6
Cabbage	15	2½	¾	7	2	1½	½	7	9
Carrots	13	1¼	¼	9½	1½	½	$\frac{1}{10}$	10	9
Sugar Beet	25	1¼	¼	20	2	½	$\frac{1}{10}$	20	15
Potatoes	25	2	¼	21	1	½	$\frac{1}{10}$	19	9

a characteristic taint ; all foods likely to flavour milk should be fed just after milking. Other foods, *e.g.*, cotton cakes, cocoanut cake, bean meal, tend to give a hard butter, while others, such as linseed cake, rice meal and fresh grass, tend to make butter soft and greasy. Others again, such as carrots, fresh grass and maize meal, impart a yellowish tinge to milk fat and hence to cream and butter. No foods materially or permanently affect the percentage of fat in milk, with the exceptions of fresh grass and wet grains (in large quantities) which, in addition to increasing the quantity of milk, slightly lower the quality.

5. CUMULATIVE EFFECT ON THE COW.—A few foods when fed in large quantities and for a long period affect the health of the animal so that her breeding powers may be seriously impaired and her constitution weakened. Wet grains are notorious in this respect, while on the continent the excessive use of molasses and of other sugar foods is credited with a similar effect.

6. COST.—The cost is not as a rule considered when working out balanced rations, but as this is most important from a farmer's point of view the approximate cost of all the suggested rations is given below. Mangels are valued at 10s. per ton, hay at 60s., oat straw at 40s., and the various concentrated foods at the figures given in brackets. The results thus arrived at indicate generally what should be the cost of feeding, but it should be clearly recognised that skilful farming to produce home-grown crops cheaply and keen buying of purchased foods should *reduce the cost of these rations to lower figures.* The selected prices are open to criticism, but they will serve a good purpose if farmers are encouraged to calculate the cost of rations in present use ; the College investigations during the present year have shown the necessity for this in many cases.

Foods Available on the Dairy Farm.

The homegrown foods comprise mangels, hay and straw, with smaller quantities of cabbage and turnips belonging to the class of bulky foods, and oats, beans and varying quantities of other cereals included in the class of concen-

trated foods. The purchased foods consist of such as may be necessary to make up a balanced ration, or to supplement the home-grown supply; the exact kinds and quantities bought will vary from year to year according to price, and in certain seasons it will be well worth while calculating whether home-grown oats and beans could not be sold and economically replaced by imported maize products, cakes, etc. Each dairy farmer must make his own calculations on this point, as he alone knows the cost of railway carriage to his station, carting and grinding facilities, etc. Some farms also can always obtain a supply of wet grains, and where this is the case this food may be used winter and summer.

ROOTS.—A great range may be justly allowed in the quantity of roots given, and 50 to 70 lbs. per day may be stated as being an economical allowance, with reduction to a smaller quantity when the crop has been a poor one. From the results of investigations carried out by the College in recent years it is evident that there is a loss through feeding excessive quantities; 100 to 112 lbs. roots per day are occasionally given in seasons of plenty and there is no evidence to show that the extra 40 to 50 lbs. gives any increase in the milk; on the other hand 112 lbs. roots supply 10 gallons cold water, and this has to be raised to the body temperature before digestion can proceed—a process requiring heat, which must be partly taken from that supplied by other foods; also the effect of excessive quantities of roots in lowering the quality of the dung produced has been clearly proved in recent experiments with fattening cattle, the extra urine washing out an undue proportion of the soluble ammonia and potash compounds. Where wet grains are largely used the quantity of roots should be kept down; the practice of giving 100 lbs. mangels and 40 lbs. wet grains per day, which has been found on some farms constitutes bad feeding in every respect.

HAY AND STRAW.—The quantity of fodder required per day may be stated at 15 to 25 lbs., and of this not more than half need be of hay. The use of a wasteful amount of hay is much too common on dairy farms, and figures obtained through Kent and Surrey have shown clearly that when 20 lbs. or

more is given per day the cost of the ration is out of all proportion to the return obtained in milk. Where hay is valued at 90s. per ton it should be kept in mind that the value is almost ½d. per lb., or equal to that of Bombay cotton cake, and the food should therefore be as economically used. While one foddering of long hay or straw per day is perhaps beneficial to cows, even that is not absolutely necessary, and the whole allowance of hay and straw may be chopped and fed with roots, etc., in seasons of scarcity.

The five rations which are given below each contain at least the amounts of starch equivalent and digestible protein necessary for maintenance according to the standards suggested on page 10, and they are suitable for cows of 10½ to 11 cwt., or the average dairy shorthorn of the South of England. They are given only as types and each farmer can make variations from them to suit the conditions of his own farm. In stating the composition of rations the name "protein" hereafter always signifies "digestible protein."

Suggested Rations for Dry Cows in Calf.

AVERAGE LIVE WEIGHT 10¾ CWT.

Ration A.

	lbs.	Starch Equiv.	Protein.	Dry Matter	Cost.
		lbs.	lbs.	lbs.	
Mangels	60	4·20	·30	7·20	3d. (fully)
Hay (Meadow) ..	10	3·10	·40	8·60	3d. „
Straw (Oat) ..	10	1·90	·10	8·60	2d. „
Total ..		9·20	·80	24·40	8¼d.

Ration B.

Mangels 90 lbs.	supplying	9·40 lbs. Starch equiv.	Cost 8d.
Hay (Meadow) 10 lbs.		·85 lbs. Protein	
		19·40 lbs. Dry Matter	

(This ration is suitable only as a Maintenance Ration for cows in milk, not for dry cows heavy in calf.)

Ration C.

Mangels	30 lbs.	supplying	8·60 lbs. Starch equiv.	Cost 8¾d.
Hay (Meadow)	15 lbs		·85 lbs. Protein.	
Straw (Oat)	10 lbs.		25·10 lbs. Dry Matter	

On page 10 the theoretical requirements for a $10\frac{3}{4}$ cwt. cow are stated as 7.2 lbs. starch equivalent, containing .84 lbs. digestible protein, and the above rations therefore supply enough protein and more than enough starch equivalent. Rations made up from home-grown bulky foods will practically always show this characteristic, as such foods are relatively low in protein, and in order to supply enough, the starch equivalent content must be raised above the theoretical standard.

Ration D.

Mangels	50 lbs.	supplying	7·55 lbs. Starch equiv.	Cost 8d.
Straw (Oat)	15 lbs.		·86 lbs. Protein	
Egypt. Cot. Cake (120/–)	3 lbs.		21·54 lbs. Dry Matter	

Ration E.

Mangels	40 lbs.	supplying	8·08 lbs. Starch equiv.	Cost 8d.
Straw (Oat)	20 lbs.		·82 lbs. Protein	
Maize Gluten Feed (140/–)	2 lbs.		23·80 lbs. Dry Matter	

Rations *D* and *E* contain no hay, and purchased foods have been included to supply the necessary protein; they are well balanced in every respect and it is important to note that the cost is not increased.

Exceptional Cows.

In any dairy herd there will always be one or more cows which have the productive tendency so strongly developed that it is difficult to dry them off and get them into reasonable condition before the next calving. Such cows require special attention, and should be given 2 to 3 lbs. cake or meal per day when they are in poor order, in addition to the above suggested quantities. Maintenance and production standards and balanced rations can be very valuable aids in the economical feeding of cows, but no amount of advice from outside experts can take the place of the personal attention of a good cowman, who will study the characteristics of his animals and note those which require special treatment. Scientific knowledge and attention to practical details must go hand in hand if the best results are to be obtained.

Feeding According to Milk Yield.

The rations *A* to *E*, though stated to be for dry cows in calf, are equally suitable as basal rations for cows in full milk; they supply enough succulent and bulky foods to meet the wants of the ruminant stomach, and the further needs of the milk-producing cow can be met by giving quantities of concentrated foods in proportion to the milk yield. The practice of feeding all milking cows alike is slowly but surely dying out, and scarcely a moment's thought is necessary to show that such a method constitutes under-feeding to the cow giving four gallons per day, and overfeeding to the cow giving one gallon. In herds where milk records are kept, there is an almost natural tendency to alter the quantity of food according to the yield, although no definite system be followed, but where no records are attempted the method of feeding is often haphazard and unbusinesslike. The surprise of the farmer who studies the milk records of his herd for the first time, and finds he has no "five-gallon" cows, would in many cases be equalled and surpassed should he weigh the foods given to his cows and calculate how many are irretrievably in his debt.

The guiding principle of feeding according to milk yield may be translated into practice by allowing dry cows roots and fodder only (with exceptions as before indicated), and feeding the remainder cake and meals in proportion to the yield obtained. It is not suggested that each cow be fed individually, but rather that for the purposes of feeding the cows be divided into two or three groups, *e.g.*, group I., cows giving under 2 galls; group II., cows giving 2 to 4 galls.; and group III., cows giving over 4 galls. That some such method of feeding by groups is followed to an increasing extent by the more thoughtful and businesslike of dairy farmers is a sufficient answer to those who say that it is impracticable and cannot be done.

Mixtures of Concentrated Foods.

The following mixtures contain two, three or four foods in the proportions required to give the theoretical amount of starch equivalent and protein in a ration for milk production. For every gallon of milk yielded the cow is assumed to require

2·5 lbs. starch equivalent containing ·5 lbs. protein, and the number of lbs. of the foods stated supplies approximately this amount. Owing to the fact that most of the concentrated foods are proportionately rich in protein the mixtures containing the theoretical amount of that substance are often low in starch equivalent, but it was noted on page 70 that the bulky foods constituting the basal part of the ration usually supply an excess in this direction, so that the bulky and concentrated parts of the ration balance each other in this respect.

To avoid repetition in stating the mixtures it should be kept in mind that decorticated cotton cake and soya cake are regarded as exactly interchangeable, and the cheaper of the two should therefore be used; the same holds good with regard to bean meal and pea meal. Egyptian cotton cake and Bombay cotton cake are also very similar in composition, but the slightly higher percentages of protein and oil in the former warrant a slightly higher price. As before, the term "protein" always means "digestible protein."

Suggested Mixtures for Cows in Milk—

In addition to Bulky Foods (*Rations A to E*).

Series I.—Excluding Wet Grains.

Mixture 1.

	Lbs.	Starch Equiv.	Protein.	Cost.
		lbs.	lbs.	
Oats, crushed (140/–) ..	$1\frac{1}{2}$	·94	·13	1d. (fully).
Bean Meal (180/–) ..	2	1·37	·38	2d. (about).
Total	$3\frac{1}{2}$	2·31	·51	3d.

$3\frac{1}{2}$ lbs. of Mixture per 1 gallon of milk. Cost 3d.
$10\frac{1}{2}$ „ „ „ 3 gallons „ Cost 9d.

This mixture consists of foods which may be produced on the farm; the prices charged above are market prices and allow the farmer a profit on his crops, if the foods be charged at an *estimated cost of production on the farm*—say £5 per

ton for oats, and £6 10s. per ton for beans—then the cost of the mixture is reduced to 2¼d. per 3½ lbs. Such a reduction can be made in all the rations containing home-grown oats, beans or peas.

Mixture 2.

Oats, crushed (140/–)	1 lb.	supplying	2.04 lbs. Starch equiv.
Bean Meal (180/–)	1 lb.		.49 lbs. Protein.
Maize Gluten Feed (140/–)	1 lb.		

3 lbs. of Mixture per 1 gallon of milk. Cost 2½d.
9 „ „ „ 3 gallons „ Cost 7½d.

Mixture 3.

Oats, crushed (140/–)	1 lb.	supplying	2·04 lbs. Starch equiv.
Bean Meal (180/–)	1 lb.		·56 lbs. Protein.
Bombay Cot. Cake (110/–)	2 lbs.		

4 lbs. of mixture per 1 gallon of milk. Cost 3d. (about).
12 „ „ „ 3 gallons „ Cost 8½d. (fully).

This mixture contains slightly above the theoretical amount of protein, and as the chief conponents are of known binding tendency it should be used with fairly laxative basal rations similar to *A* and *B*.

Mixture 4.

Soya Cake or Meal (150/–)	1 lb.	supplying	2·38 lbs. Starch equiv.
Maize Germ Meal (140/–)	2 lbs.		·51 lbs. Protein.

3 lbs. of Mixture per 1 gallon of milk. Cost 2⅓d.
9 „ „ „ 3 gallons „ Cost 7d.

Mixture 5.

Oats, crushed (140/–)	1 lb.	supplying	2·34 lbs. Starch equiv.
Maize Gluten Feed (140/–)	1 lb.		·54 lbs. Protein.
Bran (100/–)	1 lb.		
Dried Grains (120/–)	1 lb.		

4 lbs. of Mixture per 1 gallon of milk. Cost 2½d. (fully).
12 „ „ „ 3 gallons „ Cost 8d.

This mixture is well balanced though it contains no cakes, and 4 lbs. would have the appearance of a much larger quantity as all the foods are light in proportion to their bulk.

Mixture 6.

	lbs.	Starch Equiv.	Protein.	Cost.
		lbs.	lbs.	
Oats, crushed (140/–) ..	2	1·26	·18	1½d.
Soya Cake or Meal (150/–)	1	·68	·34	¾d. (fully)
Total	3	1·94	·52	2⅓d.

3 lbs. of Mixture per 1 gallon of milk. Cost 2⅓d.
9 ,, ,, ,, 3 gallons ,, Cost 7d.

Mixture 7.

	lbs.	Starch Equiv.	Protein.	Cost.
		lbs.	lbs.	
Oats, crushed (140/–) ..	2	1·26	·18	1½d.
Decort. Cotton Cake (160/–)	1	·71	·34	¾d. (fully)
Sugar Food or Treacle (100/–)	1	·50	·02	½d. (fully)
Total	4	2·47	·54	3d.

4 lbs. of Mixture per 1 gallon of milk. Cost 3d.
12 ,, ,, ,, 3 gallons ,, Cost 8½d.

Mixtures 6 and 7 differ only in the inclusion of sugar food in the latter, and this makes the mixture better balanced. Mixture 6 is slightly deficient in starch equivalent and is suitable for use with basal rations containing a full allowance of roots, *e.g.*, rations A and B, while mixture 7 would go well with a ration containing a smaller quantity of roots; the sugar food can be looked on as a substitute for roots.

The numerous sugar foods on the market vary in quality according to the amount of molasses or treacle absorbed, and the feeding value of the materials used as absorbents. Generally speaking, it would be more economical for the farmer to buy the treacle in barrels, mix the required quantity with warm water and add it to the heap of chaffed hay, straw, etc. several hours before feeding, making sure that the mixture is well stirred.

Mixture 8.

Dried Grains (120/–)	2 lbs.	supplying	1·87 lbs. Starch equiv.
Egypt. Cot. Cake (115/–)	1 lb.		·53 lbs. Protein.
Bran (100/–)	1 lb.		

4 lbs. of Mixture per 1 gallon of milk. Cost $2\frac{1}{2}$d.
12 ,, ,, ,, 3 gallons ,, Cost $7\frac{1}{2}$d.

This ration is low in starch equivalent, but would go well with basal rations similar to *A* and *B*, *i.e.*, with a full allowance of roots. The addition of 1-lb. treacle would increase the starch equivalent to near the theoretical amount, and the mixture would then closely resemble 7; with the treacle added, the cost would be for 5 lbs. 3d. (about), and for 15 lbs., $8\frac{3}{4}$d.

Mixture 9

Egypt. Cot. Cake (115/–)	2 lbs.	supplying	2·24 lbs. Starch equiv.
Maize Gluten Feed (140/–)	1 lb.		·55 lbs. Protein.
Rice Meal (120/–)	1 lb.		

4 lbs. of Mixture per 1 gallon of milk. Cost $2\frac{1}{2}$d. (fully).
12 ,, ,, ,, 3 gallons ,, Cost 8d.

SERIES II.—INCLUDING WET GRAINS.

In studying the following mixtures it should be kept in mind that the quantity of wet grains is stated in *lbs. per gallon of milk*; in the actual feeding the grains and meals may be fed separately or mixed according to the local custom.

Mixture 10.

	Lbs.	Starch Equiv.	Protein.	Cost.
		lbs.	lbs	
Wet Grains (23/–)	5	·75	·20	·6d.
Bean Meal (180/–)	1	·67	·19	1·0d.
Middlings (140/–)	1	·74	·12	·75d.
		2·16	·51	$2\frac{1}{3}$d.

Wet Grains 5 lbs.
Meals 2 lbs. } per 1 gallon of milk. Cost $2\frac{1}{3}$d.

Wet Grains 15 lbs.
Meals 6 lbs. } per 3 gallons of milk. Cost 7d.

Mixture 11.

Wet Grains (23/-)	6 lbs.	supplying	2·20 lbs. Starch equiv.
Oats, crushed (140/-)	1 lb.		·52 lbs. Protein.
Bean Meal (180/-)	1 lb.		

Wet Grains 6 lbs., Mixture 2 lbs. per 1 gallon of milk. Cost $2\frac{1}{2}$d. (about).

Wet Grains 18 lbs., Mixture 6 lbs. per 3 gallons of milk. Cost $7\frac{1}{2}$d.

Mixture 12.

Wet Grains (23/-)	6 lbs.	supplying	2·21 lbs. Starch equiv.
Maize Gluten Feed (140/-)	1 lb.		·56 lbs. Protein.
Sharps (125/-)	1 lb.		

Wet Grains 6 lbs., Mixture 2 lbs. per 1 gallon of milk. Cost $2\frac{1}{4}$d. (fully).

Wet Grains 18 lbs., Mixture 6 lbs. per 3 gallons of milk. Cost $6\frac{1}{2}$d.

Mixture 13.

Wet Grains (23/-)	8 lbs.	supplying	2·20 lbs. Starch equiv.
Bean Meal (180/-)	$1\frac{1}{2}$ lbs.		·60 lbs. Protein.

For 1 gallon of milk. Cost $2\frac{1}{2}$d. (about).

Wet Grains 24 lbs., Bean Meal $4\frac{1}{2}$ lbs. For 3 gallons of milk. Cost $7\frac{1}{4}$d.

Mixture 14.

Wet Grains	(23/-)	8 lbs.	supplying	2·23 lbs. Starch equiv.
Oats, crushed	(140/-)	1 lb.		·56 lbs. Protein.
Egypt. Cot. Cake	(115/-)	1 lb.		

For 1 gallon of milk. Cost $2\frac{1}{4}$d. fully.

Wet Grains 24 lbs., Oats and Cake 6 lbs. For 3 gallons of milk. Cost 7d.

Mixture 15.

Wet Grains	(23/-)	10 lbs.	supplying	2·46 lbs. Starch equiv.
Oats, crushed	(140/-)	1 lb.		·58 lbs. Protein.
Bean Meal	(180/-)	$\frac{1}{2}$ lb.		

For 1 gallon of milk. Cost $2\frac{1}{2}$d.

Wet Grains 30 lbs., Oats and Meal $4\frac{1}{2}$ lbs. For 3 gallons of milk. Cost $7\frac{1}{2}$d.

Mixtures 12 to 15 in Series II. are considerably above the theoretical amount of protein, while the starch equivalent is about right ; if these mixtures had been made up so as to have the protein nearer the theoretical standard the starch equivalent would have been too low, and keeping in mind the forcing effect of wet grains, it is considered advisable to have a full allowance of starch equivalent, though this should mean an excess of protein.

MAXIMUM OF WET GRAINS.

As the quantity of wet grains is stated in lbs. per gallon of milk, according to the above suggestions a five-gallon cow would be getting 40 to 50 lbs. per day with mixtures 14 and 15. Although 40 lbs. per day is a fairly common allowance on some farms, it is doubtful if this quantity is really economical in a herd where the cows are expected to breed regularly, and to meet the case of heavy milkers it is suggested that such cows should not get more than 30 lbs. grains per day, and that the necessary balance of food be made up by such mixtures of cakes and meals as 1, 2, 3, 4, or 6. This would complicate the method of feeding slightly, but if some such system were adopted, and cows which get wet grains always when in milk allowed a complete change of food when dry, and brought into good condition before calving, it is likely that the well-known "wearing" effect due to the use of excessive quantities of wet grains may be somewhat lessened.

Wet grains are also more effective than most foods in increasing the quantity and at the same time lowering the quality of the milk yielded, and where large quantities (30-40 lbs. per day) are fed this latter effect should be kept in mind in the feeding of freshly-calved cows, and precautions taken to avoid having the milk below the legal minimum.

The mixtures of bulky foods given in rations *A* to *E* (pages 69-70), and those of concentrated foods in the two series stated above, do not by any means exhaust the possible combinations of roots, fodder, cakes and meals which are at the disposal of the dairy farmer ; they only illustrate balanced rations which can be made up from the home-grown and purchased foods, and all of which are satisfactory for the end in view, while at the

same time no particular one can be singled out as the "best"—there is no universal "best ration" for milk production.

Practical Illustrations.

The following illustrations will show how the foregoing suggestions may be used by the farmer:—

CASE I.—A dairy farm with a good supply of home-grown roots, fodder, oats and beans.

Bulky foods as in *Ration A*.

Mangels, 60 lbs. Hay, 10 lbs. Straw, 10 lbs.	Roots cut or pulped, half to two-thirds of the fodder chopped and mixed with roots, remainder fed long.

Concentrated foods as in *Mixture* 1.

Crushed oats and bean meal mixed in the proportion of 1½ cwts. of oats to 2 cwts. bean meal, and 3½ lbs. of the mixture fed per gallon of milk.

	Starch Equiv.	Protein.	Cost.
A 4-*gallon cow* would get:—	Lbs.	Lbs.	
From bulky foods (basal ration)	9·20	·80	8¼d.
From 14 lbs. mixture	9·24	2·04	9d.
Total	18·44	2·84	17¼d.
Theoretical Requirements ..	17·20	2·84	

In the actual feeding a proportion of the meal mixture (say 3½ lbs. per cow) could be mixed with the roots and chopped fodder, while the remainder of the meal could be given to the individual cows according to the milk yield. Weekly or fortnightly weighings of the milk would enable the cows to be divided into groups averaging 2 gallons, 3 gallons, 4 gallons, etc. If the home supply of oats or beans were limited, mixtures 2 and 3 could be adopted, especially if maize foods or cotton cakes were cheap in the autumn.

[Where the gallon measure is in common use on farms, as is frequently the case in Kent, the weight of a gallon of the meal

mixture can be ascertained, and the cowman instructed to feed so many gallons of this mixture to such and such cows. This method has been employed with distinct success at the College farm at Wye, and it has the merits of simplicity and economy of time; the meal or meal and cake mixture is prepared once every two or four weeks, and five minutes each week or fortnight is all the time required to chalk up each cow's allowance of mixture on the wall above her head.]

CASE II.—A dairy farm where there is a good supply of roots and hay, but no home-grown oats or beans available.

Bulky foods as in *Ration B.*

Mangels, 90 lbs.
Hay, 10 lbs.

Concentrated foods as in *Mixture* 4.

Soya cake or meal (or decorticated cotton cake or meal) and maize germ meal mixed in the proportion of 1 cwt. soya cake to 2 cwts. maize germ meal, and 3 lbs. of mixture fed per gallon of milk.

	Starch Equiv.	Protein.	Cost.
A 5-*gallon cow* would get :— ..	Lbs.	Lbs.	
From bulky foods (basal ration) ..	9·40	·85	8d.
From 15 lbs. mixture	11·90	2·55	12d.
Total	21·30	3·40	20d.
Theoretical Requirements ..	20·70	3·34	

CASE III.—A dairy farm where there is a moderate supply of roots and fodder, and wet grains are easily obtained.

Bulky foods as in *Rations D or F.*

Mangels, 40 lbs.
Straw-Oat, 20 lbs.
Maize Gluten Feed, 2 lbs.

Roots pulped and part of the straw chopped and mixed with the meal, remainder of straw fed long.

Wet Grains and concentrated foods as in *Mixture* 15.

The grains can be fed separately, and the oats and Egyptian cotton cake can be mixed in equal proportions by weight and the mixture fed at the rate of 2 lbs. per gallon of milk.

	Starch. Equiv.	Protein.	Cost.
A 3-*gallon cow* would get :—	Lbs.	Lbs.	
From basal ration	8·08	·82	8d.
From 24 lbs. Grains and 6 lbs. Meals	6·69	1·68	7d.
Total	14·77	2·50	15d.
Theoretical Requirements ..	14·70	2·34	

In a breeding herd cows giving more than 3 gallons per day could get an extra allowance of oats and cotton cake—say 4 lbs. of the mixture for every extra gallon.

	Starch Equiv.	Protein.	Cost.
A 5-*gallon cow* would get :—	Lbs.	Lbs.	
From basal ration	8·08	·82	8d.
From 24 lbs. Grains and 6 lbs. mixture	6·69	1·68	7d.
From 8 lbs. Mixture	4·12	·98	5½d.
Total	18·89	3·48	20½d.
Theoretical Requirements ..	20·70	3·34	

In these three illustrations it will be noticed that the quantities of starch equivalent and protein in the suggested rations are very close to the theoretical requirements or standards. As the standards are to be looked on simply as guides to enable one to build up balanced rations, absolute agreement is not to be expected, even if it were obtainable ; a 10 per cent. to 15 per cent. variation above or below the standard would probably make no appreciable difference in the efficiency of a ration.

CONCLUSION.

Where it is already the custom to keep milk records, whether by daily, weekly, fortnightly or even monthly

weighings, the information is ready to hand to enable the farmer to group his cows and feed the concentrated food according to milk yield. Where milk records are not kept then it must be clearly recognised that their introduction forms the first step towards a rational system of feeding. The benefits accruing from milk records in the way of increased knowlege as to how to " weed " and " breed " have been repeated in lectures and in the agricultural press until the subject has almost become stale; but the benefits following increased knowledge as to how to " feed " have received much less attention, yet the financial advantages can be made at least as evident in this respect as in any other. If a saving of 1d. per gallon of milk produced can be effected, this will amount to £60 in the winter six months with a herd of 40 cows, averaging two gallons per day—a very handsome return for the first cost of a recording outfit (40s.), and the slight increase in labour involved in the periodical weighing of the milk and the food.

While the increased demand for farms, the scarcity of labour, and rise in the price of foods and the prospect of more stringent regulations tend to raise the cost of production, it is well worth while to keep in mind that the use of milk records for the detection of the unprofitable cow, and as a guide to economical feeding, is the simplest and best method whereby the cost of production may be lowered.

VALUE OF MILK RECORDS.

Table showing Actual Returns and Costs in a Herd of 18 Cows.

Group I.					Group II.					Group III.				
No. of Cow.	Wks. in Milk.	Milk Yield.	Milk Fat.	Value of Milk at 8d. per gall.	No. of Cow.	Wks. in Milk.	Milk Yield.	Milk Fat.	Value of Milk at 8d. per gall.	No. of Cow.	Wks. in Milk.	Milk Yield.	Milk Fat.	Value of Milk at 8d. per gall.
		galls.	%				galls.	%				galls.	%	
L 28	39	495	3·51	£16 10 0	S 13	44	648	3·49	£21 12 0	S 3	61	1090	3·54	£36 6 8
L 30	50	494	3·54	£16 9 4	L 26	36	613	3·57	£20 8 8	L 22	50	1005	3·37	£33 10 0
S 12	27	405	3·37	£13 10 0	L 13	36	608	3·46	£20 5 8	S 8	46	795	3·69	£26 10 0
L 33	28	384	3·36	£12 18 0	S 24	54	580	3·23	£19 6 8	S 14	47	789	3·57	£26 6 0
R.P.	38	364	3·57	£12 2 8	S 25	40	514	3·48	£17 2 8	S 11	44	735	3·48	£24 10 0
L 27	25	310	3·11	£10 6 8	L 21	33	507	3·60	£16 18 0	S 1	43	727	3·65	£24 8 4
	34½	408	3·41	£13 12 5	Av'ge	40½	578	3·47	£19 5 6	Av'ge	48½	856	3·53	£28 11 2
Cost of Food and Labour					Cost of Food and Labour					Cost of Food and Labour				
Average per cow ..				£14 15 0	*Average per cow* ..				£16 5 0	*Average per cow* ..				£19 15 0
Loss per cow ..				**£1 2 7**	**Profit per cow** ..				**£3 0 6**	**Profit per cow** ..				**£8 16 2**

Depreciation and Litter balanced by Calf and Manure.

POULTRY.

By H. Howes.

The season of 1912 was most trying to the poultry breeder. Continuous wet weather and lack of sunshine prevented the birds making any rapid progress. The stock, however, was in a very healthy condition, and by the introduction of new stock birds, the coming season should be a successful one.

In addition to the breeds now kept, *viz.*, Buff Orpingtons, Speckled and Light Sussex, Brown, Black and White Leghorn, Black Langshans and Faverolles, we now have a splendid pen of Silver Campines (Everlasting Layers). The breed is fast becoming popular and the demand for them is very encouraging. They are certainly a handsome breed, extraordinary layers of large white eggs, non-sitters and good foragers. Exhibition birds should be bred from this pen, thus enabling students to understand the preparation of birds for the show pen. Pens of Indian Game—Dorking, and Faverolle—Buff Orpington are mated for the production of first-class table fowls, and Leghorn—Wyandotte, Langshan—Minorca for laying purposes.

Aylesbury Ducks, Toulouse Geese, White and Bronze Turkeys are also kept. Practical demonstrations are given on plucking, trussing and general management. The incubators have proved a source of interest and students have been able to gather practical knowledge in natural and artificial incubation and rearing.

REPORTS

FROM THE

HOPS, HORTICULTURAL,

ETC.,

DEPARTMENTS.

THE FRUIT DEPARTMENT.

By C. S. Smith.

The 1912 fruit season was remarkable for heavy crops of many kinds of fruit, notably Cob Nuts, early and mid-season Apples and Damsons; a large proportion of the latter crop was wasted owing to the wet season, the fruit in many cases never ripening. The dry spring accounted for a shortage in the crop of Strawberries, Raspberries and Loganberries, consequently these fruits realised higher prices than during the last few years.

In the College plantations Plums and Loganberries were our most satisfactory crops, Strawberries were a light crop, but sold well. The Apple crop was disappointing, Newton Wonder and Bramley's Seedling, of which varieties the lower plantation is mainly composed, being almost complete failures; a fairly good crop was, however, obtained from the Lane's Prince Albert trees.

The following varieties of Apple have been added to the trial plots:

Wagener, Baldwin, Cleopatra (all American varieties).

William Crump—a Seedling from Cox's Orange Pippin.

Sanspareil—Season, February to April.

Rambeur Papeleu—Season, March.

The young trees have made a fairly satisfactory growth, and among the American varieties, Winter Banana, MacIntosh Red and Orenco appear the most promising.

In the case of Plums, Giant Prune bore a small crop; this plum, which was raised by Mr. Luther Burbank, in California, appears to be productive, and may prove to be a useful commercial variety in the place of Victoria. It is

similar in colour and shape to Pond's Seedling, but it is not quite so large, it ripens about the beginning of September.

American Gooseberry Mildew caused considerable trouble during the summer, but practically all the fruit was marketed, thanks to the persistent use of Lime-Sulphur Wash.

The newly-planted trees have grown fairly well, with the exception of the Worcester Pearmains, which have cankered badly.

On November 12th, a demonstration was given of the use of explosives in Fruit Growing. The first part of the demonstration consisted of the preparation of thirteen holes for tree-planting. It is claimed that trees planted after the holes have been prepared by blasting grow three times as fast as those prepared in the usual manner. The method of preparing the holes for blasting was as follows: at each marker a crow-bar hole three to four feet deep was made, at the bottom of which a charge of 4 ozs. of cheddite was placed, the soil being then firmly tamped round it with a wooden stick. The charge of cheddite had previously been fixed to a detonanor and time fuse, the latter being of sufficient length to protrude from the ground about six inches. When all the holes had been charged the operator commenced lighting the fuses successively from the end of the row. About 30 to 50 seconds elapsed from the lighting of the fuse until the explosion, this length of time being sufficient to allow the operator to get well away. In some cases the explosion, which made a muffled sound, was sufficient to blow a quantity of top soil into the air, but as a rule the top soil was only just broken. On examining the ground in the neighbourhood of the explosion it was found loosened to a radius of five to six feet, and at the same time a large cavity two to three feet deep had been formed. All the holes had to be dug out with a spade before planting could be commenced.

The cost of each charge was about 4d., not including the labour necessary in the preparation for blasting, this compares with 1d. the cost of digging out the holes by hand.

The makers of the explosives advise the planting of the holes about two days after blasting; this was unable to be carried out because the necessary trees were not to hand;

when planting was undertaken, about two months later, the holes were in a very wet, unkindly condition, distinctly inferior to those dug by spade.

In the second part of the demonstration, six twelve-year old trees were grubbed. In each case a charge of 8 ozs. of cheddite was placed in a bore hole running diagonally under the body of the tree. This quantity was sufficient to blow the trees bodily into the air. The charge was not an economic one, costing 6½d., and probably half the quantity would have been sufficient to sever all the large roots.

according to the variety of apples packed therein. A nominal bushel box holding about 2,[illegible]00 cu. in. packed with an early variety such as Stirling Castle will contain only about 35 lbs. nett weight of fruit, whereas a smaller grade of the same variety will probably turn the scale at 38-lbs.; Wellingtons of medium size weigh about 43 lbs. per box, but the smaller grades have a nett weight per bushel of as much as 45 or 46 lbs. A standard weight per bushel is therefore impossible, and must be discarded for a package of standard capacity. Retailers continually ask for the nett weight of fruit to be stamped on each box, but this is surely unnecessary, provided the box is filled and the number of apples packed therein is clearly stated. Foreign and Colonial apples branded in this manner are sold without complaint, so that there seems no reason why an exception should be made for home-grown produce.

As experience in packing is gained so the expenses attached to the operation decrease. Although the cost of best quality box-wood shows no decrease, the grower's trade-mark can now be printed direct on to the end of the box at a cost similar to that of the paste necessary for the old form of paper label, and finally we have the introduction of grading machines which promise to do more to ease the expense and difficulties of packing than anything else.

It has been previously stated that boxes are not suitable, as a rule, for cooking apples. To meet this difficulty wooden-headed barrels similar to those used in Ireland and America have been suggested. The barrels have many advantages, they are easily and quickly packed, carry the fruit with a minimum of bruising and at the same time hold a considerably larger quantity of fruit than do the boxes. They are especially suitable for the despatch of cooking apples from Kent to the northern fruit markets, as they are sufficiently durable to stand the necessary extra handling required in conveyance by rail to London and thence by steamship for the remainder of the journey. The despatch of apples in this manner allows in some cases a saving of about sixpence per three bushels consigned over the through railway rate. It is the intention of the Association to arrange classes at the next show for apples packed in barrels in order that this form of package may be brought to general notice.

FRUIT GROWERS CONFERENCE.

A Fruit Growers' Conference, arranged by the College, was held in the Town Hall, Maidstone, on Wednesday afternoon, October 30th, 1912, the second day of the Kent Commercial Fruit Show. Mr. Fred Smith, of Loddington, presided, and the Principal read to a large audience a paper entitled "The Scope of Scientific Research in Fruit Growing." After mentioning the benefits derived from general agricultural research, and especially that carried out at the Rothamsted Experiment Station on Farm Crops, he emphasized the need for research in Fruit Growing, a need which had in many directions been hopelessly neglected in this country. At the same time he showed that results valuable to fruit growers could only be obtained after continued work over a much longer period than with farm crops, chiefly owing to the slower development and longer life of the trees, and also to their want of immediate response to changes of cultural and manurial operations.

Of the problems mentioned by Mr. Dunstan as requiring elucidation perhaps the most important is the determination of the host of factors which we at present group together and term the "individuality of the tree." The growth of wood in a fruit tree is directly opposed to its fruition, and economic fruit production depends chiefly on maintaining a balance between these opposite tendencies. Climatic and general soil conditions over which the grower has little control cause him to vary the methods of obtaining this balance. The variety of stock used and the selection of the scion for working are of primary importance, but later the methods of pruning, manuring, and the general cultivation of the land exercise the chief influence. Of these problems, he suggested as being of special importance, the determination of the general

characters and uses of the various apple stocks, and especially of the strains of paradise apple stocks, the effect of selecting scions and buds only from trees of known productivity, the reasons other than frost for the non-setting of blossoms, together with the amplification and extension of the pruning experiments already carried out at the Woburn Experimental Fruit Farm. At the same time such cultural considerations as the effect of grass under trees, the use of cover crops, and also trials of modifications of the systems of manuring, although not fundamental, must not be neglected.

Under fruit tree pathology he grouped the continued investigation of insect and fungous attacks, the predisposing causes of susceptibility to disease and the nature and causes of damage to trees produced by spray fluids. The chemical nature of spray fluids and the changes they undergo after application to the tree and their effect in the actual destruction or prevention of insect or fungous attacks were all mentioned as problems on which we possess very scanty information.

Finally while looking forward to the production of new varieties of fruits, the result of work based on plant-breeding principles as at present known, he emphasized the necessity for the severe trial of such varieties before recommending them for general planting.

The paper concluded with the outlines of the proposed scheme for the establishment of a fruit experiment station for the south-east of England, its financial aspect, and the hope was expressed that the work carried out at such a station would be of use in the advancement of fruit growing in this country, and would obtain the sympathy of all fruit growers.

A short discussion followed the reading of the paper, the chairman and Col. T. F. Honeyball speaking favourably of the general line of work indicated, while Mr. E. S. Salmon mentioned several problems connected with the spraying of trees which required elucidation.

THE HOP GARDEN.

By C. S. Smith.

The 1912 crop was far from satisfactory both as regards quality and quantity, this result being mainly if not entirely due to adverse weather conditions.

During the months of April and May there were six weeks or more without rain, which accounted for the unkindly condition of the soil in the early summer, and also for an early attack of mould.

During August, when the bine needed sunshine, the weather was wet and cold, the result being that the hops did not develop properly, while *Aphis* continued to thrive, largely owing to washing operations being impeded by continual rain.

A crop of about 9 cwts. per acre was obtained, but the quality was decidedly below the average; under the circumstances the price realized (£5 8s. per cwt.) was fairly satisfactory.

THE VEGETABLE AND GLASSHOUSE DEPARTMENT.

BY H. C. CHAPELOW.

The crops on the whole have been much better than for several seasons, the wet summer months being favourable to almost all vegetables on this soil. Potatoes.—Earlies, " Epicure " and " Ninety-fold," gave excellent crops.

The late crop, " Factors," once sprayed in early July, gave just over twelve tons per acre, with only a small percentage of diseased ones. Peas, Runner and French Beans have this year given a succession all through the season. All leaf and stem vegetables have grown very freely.

In the glasshouse, the chief crops were Cucumbers and Tomatoes. A few Pot Plants were also grown, and seedlings raised for the vegetable garden.

The Frame Ground.—The frames on hot beds were first cropped with salads, followed by melons and cucumbers till the end of August, and then again planted with lettuces for the winter and early spring.

The open ground (which had been covered with hot-beds the two previous years) was used for early Vegetable Marrows, Tomatoes, Peas, French Beans, etc. A self-blanching variety of celery, " White Plume," grown extensively round Paris, was grown on one rod of this enriched soil. The plants were put out in May at nine inches apart each way. This gave excellent results, the celery blanching perfectly without earthing up.

FORESTRY.

By A. H. Haines.

The Nursery.—Area, ¾ acre.

The soil was of a poor chalky nature when taken over, but has been much improved by the planting of trees and manuring. The plot was trenched to a depth of two feet after a crop of Lucerne, which was dug in, and allowed to remain in this state for a year, when half was stocked with trees and half with potatoes and turnips.

The aspect is northern, and a gentle slope of one in twenty-nine ensures good drainage.

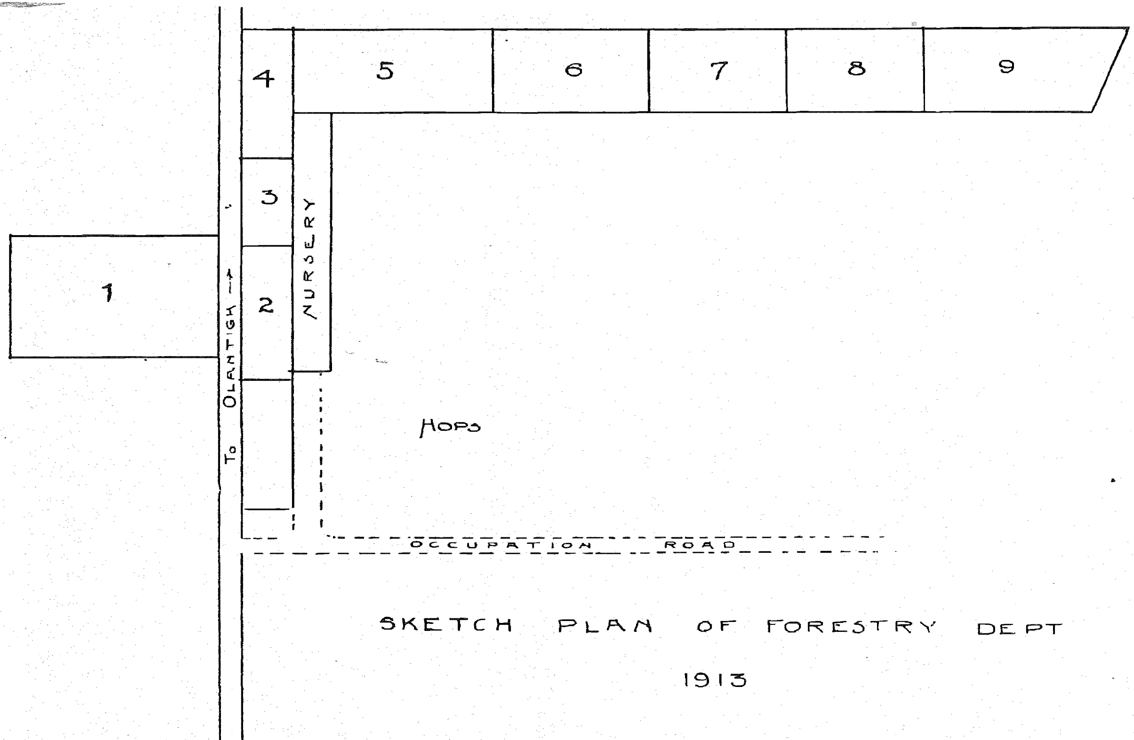
At present it is stocked with a large variety of trees including :—

Corsican Pine	.. *Pinus laricio.*
Japanese Larch	.. *Larix leptolepis.*
Scots Pine	.. *Pinus sylvestris.*
Norway Spruce	.. *Picea excelsa.*
Sitka Spruce	.. *Picea sitchensis.*
Douglas Fir	.. *Pseudotsuga Douglasii.*
Cupressus Macrocarpa.	
Pinus Gerardiana.	
Ash	.. *Fraxinus excelsior.*
Black Walnut	.. *Juglans nigra.*
Penduncculate Oak	.. *Quercus pedunculata.*
Sessile Oak	.. *Quercus sessiliflora.*
Red Oak	.. *Quercus rubra.*
Turkey Oak	.. *Quercus cerris.*
Alder	.. *Alnus glutinosa.*
Beech	.. *Fagus sylvatica.*
Hornbeam	.. *Carpinus betulus.*

Wych Elm	..	*Ulmus montana.*
Lime	..	*Tilia Europæa.*
Snowy Mespilus	..	*Amelanchier canadensis.*
Holly	..	*Ilex aquifolium.*
Elm	..	*Ulmus campestris.*
Mountain Pine	..	*Pinus montana.*
Silver Fir	..	*Abies pectinata.*
Thuja gigantea.	..	
Sequoia Wellingtonia.		
Austrian Pine	..	*Pinus Austriaca.*
Mountain Ash	..	*Pyrus aucuparia.*
Birch	..	*Betula alba.*
Sycamore	..	*Acer pseudoplatanus.*
Willows	..	*Salix alba,* etc.
Black Poplar	..	*Populus nigra.*
Cupressus Lawsoniana.		
Juniper	..	*Juniperus communis.*
Purple Beech	..	*Fagus sylvatica purpurea.*
Service Tree	..	*Pyrus sorbus.*
White Thorn	..	*Cratægus oxyacantha.*
Norway Maple	..	*Acer platanoides.*
Hazel	..	*Corylus avellana.*
Yew	..	*Taxus baccata.*
Laurestinus.	..	

The following trees will be added shortly :—

Common Wild Cherry	..	*Prunus avium.*
American or White Elm	..	*Ulmus Americana.*
White Alder	..	*Alnus incana.*
Acacia or Locust Tree	..	*Robinia pseudacacia.*
White or American Ash	..	*Fraxinus Americana.*
Oregon Ash	..	*Fraxinus Oregona.*
Green Ash	..	*Fraxinus viridis.*
Horse Chestnut	..	*Æsculus hippocastanum.*
Evergreen or Holm Oak	..	*Quercus ilex.*
Eastern Plane Tree	..	*Platanus orientalis.*
Western Plane Tree	..	*Platanus occidentalis.*
White Poplar	..	*Populus alba.*
Aspen Poplar	..	*Populus tremula.*
Spanish Chestnut	..	*Castanea vulgaris.*



SKETCH PLAN OF FORESTRY DEPT

1913

Tulip Tree	..	*Liriodendron tulipifera.*
Sitka Cypress	..	*Cupressus Sitchensis.*
Western Larch	..	*Larix occidentalis.*
Kurile Larch	..	*Larix Kurilensis.*
Siberian Larch	..	*Larix Siberica.*
Star Cluster (or Maritime Pine)	..	*Pinus pinaster.*
Banks's Pine or Jack Pine	..	*Pinus Banksiana.*
Weymouth Pine	..	*Pinus Strobus.*
Abies Concolor.		
White Spruce	..	*Picea alba.*
Chili Pine	..	*Araucaria imbricata.*
Black Italian Poplar	..	*Populus canadensis.*

PLOT I.

This plot is about 2½ acres in extent and consists of Coppice with Standards. The Coppice is mainly Ash and Sallow, and was cut over in 1903. The Standards are all Oak.

It is proposed to keep this plot as it is now, *viz.*, Coppice with Standards, as being typical of most Kentish woodlands. The rotation proposed is fifteen years for the Coppice, and sixty years for the Standards.

The Coppice is very gappy at present and full of rubbish. When next cut over it is to be planted up with Ash in such a way as to have a stool or tree every five feet.

The Standards are far too numerous to allow of good Coppice under them, and they are too much of an age. It is proposed to count them and cut one quarter of them when the Coppice is next cut; one third of the remainder at the next cut; one half of the remainder at the next cut; and the rest at the next cut. Thus after four rotations of Coppice, *all* the Oak Standards will have been felled. They will be replaced with Ash Standards. The soil is deep and moist, and well suited to the growth of high class Ash timber, which on account of its rapid growth and present scarcity, is more valuable than Oak. They would be introduced as follows: At the time when the Coppice is next cut and one quarter of the Oak Standards felled, all gaps are to be planted up with Ash, as already stated. At the time when the Coppice is next cut over and one third of the remaining Oaks felled, all the

young Ash saplings would be coppiced with the exception of some of the best grown, which would be left for Standards at the rate of about fifty to the acre. At the same time, another lot of young Ash would be put in here and there, at the rate of about seventy-five to the acre. When the Coppice next came in for cutting, and one half of the remaining Oaks were felled, the oldest Ash standards would be reduced by thinning (taking out the least promising) to about twenty per acre, whilst, at the same time, the surviving saplings planted at the last cut would be reduced by thinning to about fifty per acre.

At the next cutting of the Coppice (when the remainder of the Oaks would be felled) the oldest Ash Standards would be thinned out to about ten per acre, the next oldest to about twenty per acre, whilst the youngest would be thinned to about fifty per acre. At the same time, another seventy-five young Ash would be put in here and there, from the Nursery.

At the next cutting of the underwood, the oldest Ash Standards would be thinned out to five per acre, the next oldest to ten per acre, the next oldest to twenty per acre, whilst the youngest of all would be thinned out to fifty per acre, and as before, another seventy-five would be planted. The new sixty-year rotation for the Standards would then be in full swing, and each acre would ultimately contain :—

5 Ash Standards 60 years old.
10 Ash Standards 45 years old.
20 Ash Standards 30 years old.
50 Ash Standards 15 years old.

Plot II.

This plot is 1 acre in extent, and when taken over in 1905 consisted of Coppice—Ash, Sycamore and Norway Maple—with Larch Standards at the top end. The Coppice was very gappy and full of rubbish and the Larch Standards were mostly cankered.

The idea is to convert this piece of mismanaged Coppice into an Oak and Beech Wood. It has therefore been cut down, leaving only such poles as seemed likely to produce timber, and has been planted up with Oak and Sweet Chestnut alternately, in lines 2½ feet apart, with 2½ feet between the trees in the lines. This is an unusual mixture, but the idea is, that

when the first thinning takes place in about twenty years time, the Chestnut will be valuable in the hop garden. (There are a few lines of Oak and Ash instead of Oak and Chestnut, as the Chestnut ran short one year.)

Owing to the dense growth of rubbish it was found necessary, after felling the existing crop, to dig lines across the plot and plant the young trees in them.

Since planting, the Larch have been entirely removed, as they were badly cankered. The crop has had to be cleaned for three years after planting owing to the heavy growth of weeds and grass, but the young trees have got their heads clear now, and there is no further need of this attention, though the progress is poor and slow. The future management will be as follows :—At about twenty years of age there will be a heavy thinning, when all the Chestnut and any unthrifty Oaks will be taken out and the whole under-planted with Beech.

Mean height in 1913 :—Oak, 48 inches.
Chestnut, 36 inches.
Ash, 30 inches.

Plot III.

Pure Ash, area ½ acre. Planted in 1907, October and November.

Method of planting. Equidistant lines, 3 by 4.

When this area was cleared the following produce was obtained and sold :—

17 Larch Hop poles, at 4d. each.
138 Hop poles, 18ft., at 4s. 6d. per 100.
600 Thatching rods, 10 to 14ft., at 2s. 6d. per 100.
225 Flower sticks, at 2s. per 100.
400 Poles, at 3s. per 100.
25 Faggots, at 10s. per 100.
20 Bushels of firewood, at 4d. per bushel.

These prices are for the most part low, but there was practically no demand; the wood was of inferior quality, the soil being poor, and was much injured in its early stages of growth by rabbits.

The cost of clearing, grubbing, trenching and planting was £9 10s. The Ash transplants were raised from seed in the

College Nursery and planted after deep trenching as described above.

Cleaning was unnecessary after planting, as the young trees were of a mean height of two feet when put in.

They have not done well, as is often the case with young hardwood trees, especially Oak and Ash, and part of them were cut over at the collar in the spring of 1913.

The future treatment will be the same as that proposed for Plot II. Mean height of remaining trees in 1913, 33 inches.

Plot IV.

Underwood composed chiefly of Sallow and Norway Maple with some Beech, Ash and Hazel. Area $\frac{3}{4}$ acre. This piece is used for demonstration purposes in layering, planting, pruning, etc.

Plot V.

Pure Spruce.—Area $1\frac{1}{2}$ acres.—Rise 1 in 23. Notch-planted in 1906.

Method of Planting.—Square 4 ft. by 4 ft. (2,722 trees per acre.)

Cost of trees.—Two-year seedlings, 5s. per 1,000.

This plot shows the evils which may attend notch-planting under certain conditions. Owing to deaths the area had to be re-stocked in the following year. This gives the plantation its appearance of being over-crowded. All the best trees now growing are the result of the second planting, the stunted ones being those which were notch-planted.

In the second planting two-year transplants were used, costing 25s. per 1,000 (purchased from Messrs. Clibrans, Altrincham), and these were pit-planted at a cost of 2s. 6d. per 100. Cleaning was necessary in the following year, and this cost 18s. per acre.

Mean height in 1913, 54 inches.

Plot VI.

Pure Corsican.—Area 1 acre.—Rise 1 in 28. Pit-planted in Spring, 1908, with six to twelve inch plants, twice transplanted, costing 35s. per 1,000. (Purchased from Messrs. Stewart, Wimborne.)

Method of Planting.—Square, 4 ft. by 4 ft., with the exception of seven rows at the top end which were planted with two-year seedlings at 3 ft. by 3 ft., costing 6s. 6d. per 1,000.

This species suffered much less from rabbit attacks than the rest, as is generally the case, but in spite of the information given in Nurserymen's Guides to Planters, it cannot be planted *with impunity* in districts infested with hares and rabbits.

It is a notoriously bad transplanter owing to its poor root system, and should be put in in the spring preferably. Three-year-old trees, twice transplanted in the Nursery, succeed best.

The cost of establishing this crop—always a difficult one—with its subsequent cleaning, was £8 per acre. Some "gapping up" has been done with a few Scotch Pine and Douglas Fir from the Nursery.

Mean height in 1913:—Main crop, 48 inches.

The seven rows at top end 12 inches.

Plot VII.

Pure Scotch Pine.—Area, 1 acre. Rise 1 in 22.

Method of Planting.—Square, 4 ft. by 4 ft. (2,722 trees per acre.)

This area is divided into three lots. The first lot of twenty-nine rows is marked by a white stake driven into the ground at the side of the twenty-ninth row. These trees were bought from Messrs. Dicksons & Co., 1, Waterloo Place, Edinburgh, and put in direct on ploughed land.

The second lot of forty-seven rows (also marked by a white stake driven into the ground at the forty-seventh row), were taken out of the College Nursery, where they had been once transplanted, and planted on ploughed land. These two lots were planted out in 1910, and the age of the trees was the same in both cases.

A considerable difference will be observed between the home-schooled trees and those bought from the Nurserymen.

The third lot was planted in 1911 with trees from Messrs. Dicksons, on the stubble after a crop of oats.

Cost of Seedlings, 3s. 6d. per 1,000. Cost of Transplants, 20s. per 1,000.

A great deal of "gapping up" was required in the upper and lower parts, and rabbits have been destructive.

Mean height in 1913:—First lot—33 inches.
Second lot—42 inches.
Third lot—36 inches.

Object of Plot.—The object of Plots V., VI. and VII. is to illustrate the growth and yield of pure woods of Spruce Fir, Corsican and Scotch Pines; to compare the Scotch with the Coriscan Pine; method of thinning; and, later on, the under-planting of a pure Pine wood with Beech.

Of these three crops the Scotch has proved itself easiest to establish, and the Corsican the most difficult. Similar evidence is found in the catalogues of nurserymen where the prices of transplanted Corsicans are more than double those of transplanted Scotch of equal size and age.

Plot VIII.

Even-aged Larch and Beech. Area 1 acre. Rise 1 in 15. Planted in December and January, 1912-13.

Method of planting.—Square, 4 ft. by 4 ft. (2,722 trees, per acre.) Two rows of Beech to one of Larch.

Cost of Beech, two year, two year, 35s. per 1,000.

Cost of Larch, two year, two year, 27s. 6d. per 1,000.

At the lower end there are four rows of Hornbeam and three rows of Japanese Larch, instead of Beech and European Larch.

Object of Plot. To test the advantage of mixing in this way in order to prevent the spread of Larch Disease (*Peziza Wilkommii*), which is so prevalent in the neighbourhood; the production of clean Larch; the improvement of the soil for future crops.

Mean height in 1913:—Hornbeam 30 inches.
Beech, 80 inches.
Jap. Larch, 18 inches.
European Larch, 21 inches.

Plot IX.

An unusual even-aged mixture consisting of Ash, Black Poplar and Sycamore. Area 1½ acres. Rise 1 in 9. Planted in 1913.

Method of Planting.—Square, 4 ft. by 4 ft. (2,722 trees per acre.)

Cost of Sycamore, 2 ft., 20s. per 1,000.

Cost of Ash, 2 ft., 18s. per 1,000.

Cost of Black Poplar, 2 to 3 ft., 25s. per 1,000.

Part of the crop has been planted on ploughed ground, as shown by white-painted stakes, and part on unploughed grass-land, while at the top end will be found groups of Beech, Birch, Wych Elm Black Poplar, Mountain Ash, and Ash. The Birch, Wych Elm, and Mountain Ash used in these groups have had two years in the home Nursery. The other plants were brought from Messrs. Clibrans, and put in direct.

Object of Plot.—To compare the growth of the various species on this poor and exposed situation ; to give instruction in thinning so as to preserve the most favourable species.

Mean height of trees in 1913 :—

Poplar, 33 inches.	Wych Elm, 30 inches.
Ash, 24 inches.	Birch, 33 inches.
Sycamore, 18 inches.	Beech, 20 inches.

Mountain Ash, 24 inches.

Fencing.

Students should make a note of the rabbit wire fencing used.

The wire netting is No. 17 gauge, strong galvanized, 42 inches wide and $1\frac{1}{4}$ inches mesh, costing on an average 20s. per roll of 50 yards. The top wire is three-ply, costing 2s. 6d. per 100 yards ; staples, $1\frac{1}{2}$ inch galvanised, at 20s. per cwt.

The netting is let into the ground for six inches and turned outwards, to prevent the rabbits from burrowing under. Since this netting was erected it has been found necessary to add another foot to the top. This has been turned outwards, in a manner corresponding to that part which is under the ground, and has, for the present at any rate, stopped the rabbits from jumping over. The original netting lasted for about sixteen years.

It would, of course, have been much cheaper in the first instance to buy the wire, say, 48 inches wide, and bend it

over. The cost of wire this width, if 1½ inch mesh be used, is the same price as 42 inches wide and 1¼ inch mesh.

The foot netting at the top cost 5s. 9d. per roll; it is 17 gauge and 1½ inch mesh.

Cost of Fence per 150 yards.

	£	s.	d.
Three rolls wire netting (17 by 1¼ by 42)	3	0	0
Fifty split Ash poles (4 inch diameter, 9 ft. apart at 8s. per 100		4	0
Two Larch Straining Posts (6 in. by 5 in., 7 ft. long)		5	0
Two shores			2
150 yards 3-ply strand wire (at 2s. 6d. per 100 yds.)		3	9
1½ inch galvanised stables		1	1
Labour, binding wire, etc.	1	6	0
	£5	0	0

Equals 8d. per yard run.

The following specimen trees, planted in March, 1908, may be seen at Coldharbour :—

Common Balsam Poplar ..	*Populus Balsamifera.*
Mount Altas Cedar. ..	*Cedrus Atlantica.*
Himalayan Cedar ..	*Cedrus Deodara.*
Cedar of Lebanon ..	*Cedrus Libani.*
Remarkable Pine ..	*Pinus insignis.*
Nepaul or Lofty Pine ..	*Pinus excelsa.*
Spanish Silver Fir ..	*Abies pinsapo.*
Menzies Spruce ..	*Abies menziesii.*
Cupressus Lawsoniana Stewartii.	
Weymouth Pine ..	*Pinus Strobus.*
Austrian Pine ..	*Pinus Austriaca.*
Himalayan Spruce ..	*Picea Morinda.*
Great Californian Silver Fir ..	*Abies grandis.*
Crimean Silver Fir ..	*Abies Nordmanniana.*
European Larch ..	*Larix Europæa.*
Siberian Larch ..	*Larix Siberica.*

Japanese Larch	..	*Larix Leptolepis.*
Sequoia gigantea.	..	
Douglas Fir	..	*Pseudotsuga Douglasii.*
Black Italian Poplar	..	*Populus canadensis.*
White Poplar	..	*Populus alba.*
Common Black Poplar	..	*Populus nigra.*
Lombardy Poplar	..	*Populus Pyramidalis.*
Sycamore	..	*Acer pseudoplatanus.*

BEE-KEEPING.

By J. Garratt.

The early season—April and May—was particularly favourable for the Apiary and, with the hives in strong and forward condition, the prospect of abundance of honey seemed assured. Unfortunately, the weather which succeeded, *i.e.* low temperature and little sunshine, and which continued to the end of August, entirely changed the outlook, resulting in an almost barren summer. To add to the misfortune, the disease (Isle of Wight) which has been for some time spreading through the country has invaded the Apiary, and, in the absence of any reliable remedy, it has been deemed advisable to destroy all stocks found to be so affected. In these circumstances, for the time being, it will not be prudent to restock the Apiary other than for teaching and experimental purposes.

REPORT

ON

ECONOMIC ZOOLOGY

FOR THE

YEAR ENDING SEPTEMBER 30th, 1912.

BY

FRED. V. THEOBALD, M.A., F.E.S., Hon. F.R.H.S., etc.

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INTRODUCTORY NOTE.

This Report deals with a few of the more important communications received during the year ending September 30th, 1912.

The number of communications received has been much in excess of previous years, but comparatively few of them have dealt with anything of special interest, a large proportion being in connection with spraying.

A few subjects referred to are of special interest, including an attack of an unrecorded British Sawfly (*Lygæonematus moestus*) on apple trees, an attack of the Beech Orchestes (*Orchestes fagi*) on apples, damage caused to apples by the Garden Chafer, and injury caused to cucumber blossom by Spiders and the great prevalence of Salix-feeding Aphides.

Numerous papers have been issued dealing with Aphididæ, including those feeding on Ribes (*Journal of Economic Biology*) ; Aphides attacking the Mangold and allied plants (*Board of Agriculture Journal*) ; The Green Pea Aphis and the allied species of Macrosiphum (" Proceedings of the Second International Congress of Entomology "). Special investigations on the Woolly Aphis (*Schizoneura lanigera*) have been made, but the results are held over for a few months.

Mr. Adrian Duffield is investigating the Eelworm disease in hops and Mr. C. Mason the Flea Beetles.

Owing to Mr. Mason being appointed to one of the Carnegie Scholarships by the Entomological Research Committee of the Colonial Office Mr. Duffield is carrying the work on.

My thanks are due to the following gentlemen who have kindly identified insects for me ; Professor Robert Newstead, F.R.S. ; Mr. Claude Morley, F.E.S. ; Mr. Distant, F.E.S. Mr. Gahan, M.A., F.E.S. ; Mr. Cecil Warburton M.A. ; Mr. Britten, F.E.S. ; and Professors Davis, Wilson and Newell of the United States.

The photographs illustrating this Report have been taken by Mr. Edenden of Wye.

FRED V. THEOBALD.

ANIMALS INJURIOUS TO FRUIT TREES AND BUSHES.

APPLE.

The Beech Orchestes (*Orchestes fagi* Barens) attacking Apples.

This well known beech insect was sent me from South Devon in June, and was reported as causing a serious loss to apples at Harpford, Ottery St. Mary.

Captain Chancellor, who forwarded the beetles, later sent the damaged apples with the beetles feeding on them.

The method of attack is for the beetles to settle on the fruitlets when from the size of a filbert to that of a walnut. They collected in groups and made small holes in the young apples, as many as fifteen of the weevils were found in the same hole. Some holes formed were half an inch across, others were quite small.

The attacked fruitlets also split from the seat of damage, sometimes on one side only, at others on both sides; these cracks were sometimes shallow and at others passed deep into the pulp.

The beetles sheltered, often closely packed together, in the spaces they had destroyed.

The variety mainly attacked was Cox's Orange Pippin and a large portion of the crop was ruined by them.

On receiving this somewhat startling evidence of the sudden change of habits of this beetle, I collected a number from beech trees in the neighbourhood, and placed them on an apple tree under a muslin tent; by the next day, the beetles had commenced to work in exactly similar manner to those in Devon, but they did not oviposit on the apple leaves. Further inquiries brought to light the fact that the orchards

at Harpford were surrounded by beech and oak trees. For some unknown reason, the insect changed its habits, just as the Oak Typhlocyba (*Typhlocyba querca*) has been known to do, and many other insects.*

The life cycle of the *Orchestes fagi* is briefly as follows :— The beetles hibernate under fallen leaves, beneath rough bark, pieces of wood and in hollow stalks.

In spring, when the beech leaves are still young, they come out. I have found them as early as April 10th. They are extremely active, hopping like a flea beetle off the leaves if

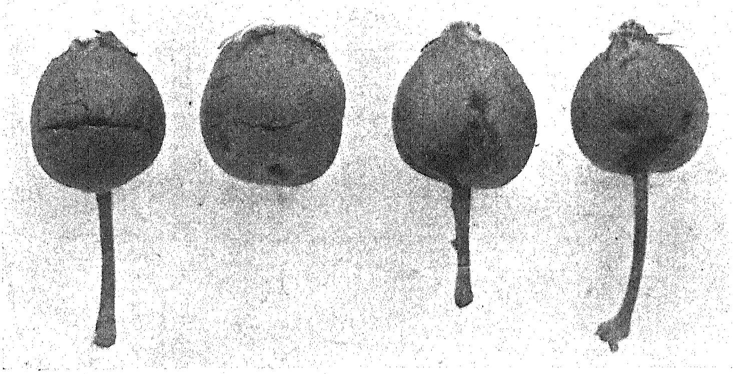

Fig. 1.

APPLES DAMAGED BY *Orchestes fagi* Barens.

touched. Gillanders† says "it does not expose itself very much during the day, but in the night-time moves on to the young leaves." In the south of England, their habits differ slightly, for I have always found them very active during the day, especially on bright, still, warm days, when hundreds may be seen jumping off the foliage when moving through beech trees. The female cuts a little slit in the mid-rib of the leaf, usually somewhere towards the middle of the leaf, and inserts a single egg in the hole, which remains as a distinct scar.

* "Journal Economic Biology," Vol. II., p. 19, Plates 1 and 2.

† "Forest Entomology," p. 80, Gillanders.

The egg hatches in from eight to twelve days, and the young larva tunnels outwards and upwards to the edge of the leaf, usually following a lateral vein, it then eats out a large chamber at the apex of the leaf, which is at first pale green. Later it becomes brown and shrivelled. This appearance has very frequently been attributed to frost.

In three weeks, the larva is full grown and then pupates in the leaf in a small white to grey cocoon, and in fourteen to twenty days hatches out as the beetle. The beetles eat out small round holes in the leaves, both those that appear early in the year and those that hatch out in June. Beech leaves, in the south of England, may frequently be seen completely ruined by the countless holes these beetles eat, and by the larval galleries. The beetle is one eighth of an inch long, slaty black to black, with grey pubescence when fresh; legs and antennæ bright brown; the hind femora are well developed much as in the Halticidæ, thus enabling the beetle to skip about. It has an ample pair of wings, which it uses frequently in bright weather, and doubtless in this way gained access to the apple trees at Harpford. I have notes of this beetle from Battle, Hastings, Lewes, Isle of Wight, Kingston-on-Thames, Godalming, Cambridge, New Forest, Worcester, Exeter, Kew, Wye, Rye, Durham and Holmes Chapel. Gillanders records it from Alnwick and Gilside, Co. Durham.

The apple trees at Harpford had been well sprayed with arsenate of lead, but this had no effect whatever on the beetles. A subsequent spraying with White's "Abol" Captain Chancellor reported was appearing to check them. I was so surprised at finding these beetles damaging apples, that I sent them to Mr. Gahan, of the British Museum, to be certain of the correct identification, and he was sure they were only *Orchestes fagi*.

It is interesting to note that in Illinois, U.S.A., an Orchestes the *Orchestes canus* of Horn, attacks apples, but in a different way.* It is called popularly the Apple Flea Beetle, a small, dull blackish weevil the same size as our Beech Orchestes. The larvæ make winding burrows or mines in the apple leaves, where they pupate. The adult beetles feed on the leaves,

* Twenty-sixth Rep. State Entomologist, pp. 83-86, figs, 18-21, 1911. Fifteenth Report of Stephen A. Forbes.

making numerous shallow pits which afterwards become holes.

Forbes points out that this beetle is evidently kept under control by a chalcid parasite, a species of *Eulophus*, the injury at present in America not being sufficiently great to make spraying necessary.

It appears that *Orchestes fagi* only attacks the fruit, as no trace of damage to the leaves was noticed in Devon, nor by those I transferred to apples at Wye.

The Apple Blossom Weevil (*Anthonomus pomorum* Linn.)

Very few marked cases of this insect pest damage were reported in 1912. Mr. Clive Murdoch, of Linton, wrote in June he had more than ever of the "red" or "capped" blossoms, and Mr. Jackson, of Stonyhill Green, Dartford, wrote on April 18th, that the weevil was doing no end of damage there.

Messrs. King-Smith of Borough Green also complained of the damage done in one part of their plantations. On this farm it seemed to be localised, and poultry were being tried as an experiment to check it. A few of the weevils were found in "Tanglefoot" bands, when I visited the farm in April.

Very many of the weevils I find hibernate in the soil at the base of the trees and come out in early April. That some of these crawl up the trees we see from their being caught in the lower part of the Tanglefoot bands and this must tend to reduce them. They certainly cannot cross this preparation.

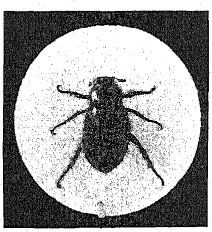

Fig. 3.
THE GARDEN CHAFER
(*Phyllopertha horticola* Fabr.)

The Garden Chafer (*Phyllopertha horticola* Fabr.) eating Apples.

Although well known as a destructive insect, in its larval stage, to grass and roots generally in Britain, I am not aware that the Garden Chafer (*Phyllopertha horticola* Fabr.) has been noticed to attack apples in its adult stage in this country.

In May, Mr. Oswald Ellis, of The Fruit Farms, Bramley, Surrey, sent

various apples badly damaged, as shown in the photograph reproduced here, with an enquiry to know if the small chafers could possibly be the culprits. Later, they were found in vast numbers and devoured the young apples ravenously. Worcester Pearmains were chiefly attacked. Many bush trees had fifty to one hundred beetles shaken from them. Placed on apples much larger than those shown in the photograph, they soon set to work, a single beetle

Fig. 3.

APPLES EATEN BY THE GARDEN CHAFER.

being observed to spoil no less than ten apples on one bright day.

A similar attack is well known in Germany. Dr. Reh* describes and figures the damage caused by this chafer.

Jarring the beetles off is the only method of fighting them. As they are active in bright weather, this should be done as far as possible, in dull weather or towards evening.

* Die Schädlinge des Obst und Weinbaues. Frankfurt, p. 41, Pl. II., fig 29, 1911.

An Unrecorded Apple Sawfly in Britain (*Lygæonematus moestus* Zaddach).

The larvæ of this sawfly, the *Lygæonematus moestus* of Zaddach, have been sent me from Week Green, near Petersfield, Hampshire, and from Mortimer, Berkshire, where they were feeding an apple foliage. I found a small colony also near Wye, on a Worcester Pearmain in 1907, but never reared them.

The larvæ were first sent me from Week Green, by Mr. T. E. Crompton, on June 6th, 1911. He found them the previous day in an orchard, one at Steep near Petersfield, and on June 10th he sent another supply, found at Froxfield, and these were considerably smaller than those first received. In the former place, a small branch only was attacked, and completely defoliated. In the latter place, they were much more plentiful and were stripping the trees in typical sawfly fashion. They commenced to pupate on June 13th, and the last on July 22nd. Some of these pupated in the soil, others on the soil, and some amongst the foliage. Those in and on the soil, covered the yellowish silk of their cocoons with fine particles of earth; those on the foliage had a thick cocoon of pale, dull yellowish silk. The adults hatched out from April 20th to May 5th, 1912. The colony from Mortimer, twenty in number, were found on a "Mother" Apple, and were sent me by Mr. S. D. Lake on June 14th, 1912. These all pupated amongst the foliage, making similar cocoons to those that pupated amongst the leaves in the previous year. Others were found at Week Green in 1912.

The larvæ are very marked in appearance and feed freely on the leaves, mainly eating them from the edge upwards, but now and then they devoured holes in the leaves.

The adult larva is apple green with a small, somewhat irregular black spot on each side of the first four segments, and a large round black spot on each side of the next seven segments, numerous small black specks on the first four segments and some on the sides of the others. Head green with black eyes. Legs green. Length half-an-inch. A few showed a more yellow tinge.

The adult is shiny black, with paler incisions on the venter; legs pale and also the base of the wings.

L. moestus Zaddach is the same as *L. brevicornis* Eh. 1862 (not of Cameron). The insects were identified by the Rev. F. D. Morice.

The Apple Fruit Sawfly (*Hoplocampa testudinea* Cameron).

This pest still persists owing to the fact that there is no method of treatment, and nothing but hand-picking can do any good. If growers would persist in this for a couple of seasons, the damage could be reduced to a minimum. It was particularly harmful to Quarrendens in 1912.

Mr. Pain, of Sevenoaks, reported that at the end of May, the Quarrendens were all badly attacked by a pink maggot. They proved to be *Hoplocampa testudinea*, but were of a decided pink hue, that I have only seen once before in some specimens sent from Suffolk.

About the same time, Mr. Mount wrote concerning this attack at Patrixbourne, where on June 3rd, serious havoc had been done, especially to Quarrendens.

The Wood Leopard Moth (*Zeuzera pyrina* Linnæus).

During the last two years, there has been a very considerable increase in the number of Wood Leopards (*Zeuzera pyrina*) both in Kent and Worcestershire.

Twenty different attacks have been reported during the past year.

It is particularly noticeable that this increase has been more in apples than in cherry and pear, which I have found previously to be their chief food plants.

Another unusual occurrence is the considerable numbers being found in a single tree, as a rule a single specimen here and there only have been recorded, and the smaller branches attacked and killed.

Writing in April, Mr. R. Tester, of East Peckham, stated that his Derbys were attacked, as many as six larvæ being found in one branch. He could easily discover where they were working on lime and salt washed trees by the brown discolorations coming from their borings showing up prominently on the white. Distinct holes were noticed and bisulphide of carbon injections were to be used.

From Oakhampton, near Stourport, Worcestershire, Mr. John Crane sent a piece of a large branch of Bramley's Seedling tunnelled by one of the larvæ. This branch was four inches across, from a ten year old half standard. The larvæ had tried to work round the branch as well as along it.

It was noticed on this tree, that there was a larval hole near the base, and that the larvæ had worked upwards. This is the first instance of the trunk of a tree being attacked as far as I have seen.

The November Moth (*Oporabia dilutata* Fabr.).

Mr. C. S. Martin, of the Toddington Fruit Plantations wrote on the 26th of October, sending a number of moths caught in grease bands, and said that they are "almost as common with us as the Winter Moth, and may account to some extent for the caterpillar attacks from which we suffer, or have sometimes suffered after careful grease-banding."

The moths proved to be the November Moth (*Oporabia dilutata*).

Later, Mr. Martin wrote that "there are very large numbers of these moths on the grease-bands this year."

Although the caterpillars of this moth are not harmful as far as I know to fruit t ees, yet the moths are in this case indirectly, for they occur in such numbers that the grease-bands are covered, and in consequence the wingless females of the Winter Moth (*Cheimatobia brumata*) can cross over the bands.

The normal food plants of the caterpillar of this moth are oak and elm, but it feeds on many other trees. So far I have not found it on fruit trees, but it may at any time take to them, and it is quite possible that the attacks referred to by Mr. Martin after grease-banding may be due to the looper larvæ of this moth.

The larvæ are green and can be told by the bluish-white ventral surface.

The moth is winged, the fore wings being pale to dark grey with some darker waved lines and bands across the front pair, whilst the hind wings are paler, often almost white, with one or two dusky lines following the outer margin, which has a row of black dots along it.

The moth occurs in the latter part of September and in October, and in some years, continues to appear until mid November.

It is subject to great variations in colour and markings.

When mature, the larvæ fall to the ground and pupate in the soil.

It is widely distributed over England, from York down to Cornwall, and is often very abundant.

Mottled Umber Moth (*Hybernia defoliaria* Clerck).

Information concerning this well-known fruit and forest tree pest was sought from Saxmundham, Suffolk, where a correspondent says it does severe damage to the fruit foliage, and also that the Winter Moths (*Cheimatobia brumata*) were abundant and the wingless females were appearing on the 21st of October.

The Gold Tail Moth (*Porthesia similis* Fues).

Considerable numbers of the young larvæ of the Gold Tail Moth (*Porthesia similis*) were received in October, 1911, and the spring of 1912, from Kent, Surrey, Sussex, Bedfordshire, and Devon and two lots from Hampshire. In the autumn, these larvæ are gregarious, feeding on the foliage and skeletonising the leaves as shown in the photo. They keep on feeding as long as the leaves hang on, and then spin up small grey cocoons in any shelter. These I have found beneath grease-bands, sacking, rough bark, and in the axils of branches. Usually numbers of these cocoons occur together, In the spring, the young larvæ come out and as they grow, do, if present in any numbers, considerable harm. They feed on practically all fruit trees and bushes, on hawthorn in hedge-rows, on elm and roses. Not only do they devour the foliage in the spring and summer, but they also eat holes in the young pears and apples, and in some instances, have been reported as damaging a large proportion of these fruits.

It is therefore, important to destroy them when in colonies, in the autumn, their presence easily being detected by the appearance of the foliage shown here. (Plate II.).

The Sycamore Coccus (*Pseudococcus aceris* Sign.) on Apple.

This marked woolly coccus, was brought to my attention in June, 1912, as occurring in considerable numbers on apple trees at Perry Court. A few of the trees which I later examined were thickly coated in places with the females, and later the white ovisacs showed up prominently even at a considerable distance.

They swarmed up the butts of the trees mostly, but many crawled up into the branches, and some to the smaller twigs which they killed.

Professor Robert Newstead identified the specimens for me.

The strange thing is, that so far I have failed to find it anywhere else in the neighbourhood, and a search has been made for some two miles around both that year and in 1913.

The food plants of this scale insect are varied, including the following :—freely on gorse (*Ulex europæus*), elm (*Ulmus campestris*) ; horse chestnut (*Æsculus hippocastanum*) ; laburnum (*Cytisus laburnum*) ; oak (*Quercus robur*) ; hawthorn (*Cratægus oxyacanthus*) ; lime (*Tilia* spp.) ; sycamore ; sweet gale (*Myrica gala*) ; mountain ash (*Sorbus aucuparia*) ; plum, (*Prunus*) and on apple (*Pyrus*) according to Newstead, and a new food plant is added here, namely, the beech, upon which trees it was doing much harm at Godalming during the same year.

Fernald (Catalogue of the Coccidæ of the World, p. 90) gives only maple as the food plant.

The females move fairly rapidly for Coccids and are found crawling about early in May. During that month, they make their white ovisacs, some were found on the trunks of the apple trees, many on the under sides of the branches, and in the angles of the twigs, in no case did I find one on the leaves, but Newstead says, "rarely on the main trunk of the tree or the leaves."

The females form the white ovisacs with great rapidity, for a week after I first visited the plantation, all had been formed.

The young commenced to hatch on June 21st, and continued to do so until the end of the month. The immature

females on one tree that was not touched, hibernated at the forks of the twigs, small branches, and some at the base of buds. On March 20th, I found many females crawling about the trunks of the trees, and for some reason, quite a number had sheltered beneath a straw band on a young tree.

I could find no trace of males.

The females are said to descend to the trunks to meet the males, who pass the winter on the main trunks under a felted puparium. The winged males, according to Newstead, appear towards the end of March, but the majority in April, and until the end of the first week in May. They do not appear to fly unless disturbed, and in wet cold weather become almost torpid and hide away in crevices in the bark. The two-winged male is smoky brown to rich madder brown, and mealy, with four caudal filaments, the inner pair long, the outer about half their length. There is no long penis as in the male of the Ash Scale. The adult female is oval and pale green with brown legs and antennæ. Newstead records some as being pale brown or brown pink, mealy. The legs are short. The ovisac is white and elongated, parallel sided when isolated, but when densely crowded, of all shapes, they varied from five to nine mm. in length.

The larvæ are bright yellow, and the ova greenish-yellow to pale yellow.

They readily yield to treatment if sprayed with paraffin jelly soon after they hatch out, and also I found caustic soda at 2½-lbs. to ten gallons of water plus ½-lb. of soft soap, to destroy the wintering females.

Localities.

Wye (Theobald); Tunbridge Wells on Ulex (Theobald); Godalming on birch (Theobald); Blackheath (Douglas); Exeter (Newstead) on limes; Brockley (Douglas) on elm; Hereford (Chapman) on oaks; Forest of Delamere, Cheshire; Oban, Scotland; Alnwick, Northumberland; Norwich and Kingshead, Norfolk; Cotswolds, Gloucestershire; Chislehurst, and surrounding district, Kent; Stratford-on-Avon, and Bournemouth on gorse; Chester on laburnum (Newstead).

It is also recorded in Continental Europe and in North America, but Newstead considers the American *P. aceris* to be distinct from the European.

Synonyms.

Pseudococcus aceris Signoret.
Pseudococcus ulicis Douglas.
Pseudococcus ulmi Douglas.
Pseudococcus quercus Douglas.
Pulvinaria ribesiæ Douglas (♂ only).
Pseudococcus socius Newstead.
Phenacoccus socius (Newst.) Cockerell.

The Mussel Scale (*Mytilaspis pomorum* Linnæus).

Some bad cases of attack by this widely distributed Coccid were reported in 1912. In February, a communication was received concerning its prevalence on apple trees at Harbledown, Canterbury, and on March 25th, another from Patrixbourne near Canterbury.

Another bad case was reported by Mr. W. M. Simpson from Kirkdale, Southport.

Specimens were also sent from Widdington, Newport, Essex, where they were covering Cox's Orange Pippins in October, ninety per cent. contained ova, but there were still some females under the scales. Some minute acari were feeding on the eggs.

At Messrs. King Smiths, Borough Green, some trees had it badly, but when I visited the farms, the trees had been sprayed with sodalin and all the scales had turned grey and nothing but brown and shrivelled ova could be found beneath. Some young trees at Admiral Goodridge's, at the Rudgewick Fruit Farms, were also found fairly covered with scale, which was also found on some of the older trees. These had been sprayed with sodalin also, and all the scales presented a similar dull grey colour, and no living ova were found beneath them.

At Wye, some trees belonging to Mr. Head were sprayed with lime-sulphur (Voss' preparation), lime-salt, and caustic soda. The lime-sulphur had little or no effect on the ova beneath the scales, the lime-salt no effect at all of any value, only two per cent. of the scales showing dead ova beneath, whilst with the lime-sulphur twelve per cent. were found dead, but with the caustic soda, eighty-seven per cent. of the scales examined had shrivelled brown ova beneath them. With the lime-salt trees, however,

especially one or two trees on which the wash had held well, very few of the young when they hatched out lived more than a few days. They apparently could not move about between the particles of lime. As they hatch out in June, when most of the mixture has gone off the trees, it cannot be advised at all for this purpose.

Caustic soda at 2½-lbs. plus 1-lb. of soft soap, appears to be by far the best winter remedy.

Both at Rudgewick and Borough Green, I looked for parasitised "scales" easily told by the round exit holes of the parasites, but did not find a single case in either place.

Red Bugs (*Atractotomus mali* Meyer) attacking Apples.

Yet another species of "bug" has to be recorded as attacking the apple.

In June, a complaint of damage was received through the King's Acre Nurseries at Hereford, concerning "a bug which is spoiling the apple trees, the leafage curls up, and shrivels, the shoots die off and the fruit also shrivels up," writes the manager.

The insects sent were all nymphæ, and so could not be identified, but by July 7th, I had bred mature specimens and these Mr. Distant kindly identified for me as the *Atractotomus mali* of Meyer*, and which he says has been mentioned as feeding on the apple.

In another communication on June 3rd, the grower wrote that "This attack has been noticed for the past two or three years, amongst our apples, making its appearance at the end of May and beginning of June—each year being more prevalent. The points of the young terminals are first attacked, causing them to stop growth entirely and later on, when the attack is over, growth recommences, then three or four shoots put forth growth just below where it had been arrested."

Another attack of the *Atractotomus mali* was also referred to me by Mr. Wm. Bear, who had received specimens from Suffolk, the grower there stating that his crop of Beauty of Bath had been practically ruined by the red bugs.

* *Rhync. sp.* 30 pl., 2 fig. 5; Saunders, *Hem. Heteroptera.* "British Isles," p. 309.

These bugs have the first segment of the antennæ thickened, the long second segment gradually thickened to the apex, and both with rather dense outstanding short hairs, the third and fourth segments filiform and pale in colour.

The nymphæ received matured on July 7th. As the nymphæ do so much damage and have not been described they are here briefly referred to.

Colour, bright red to brick dust red; head and thorax somewhat darker and also the wing buds; clothed with fine short golden pubescence. Antennæ with the first and second segments enlarged, densely clothed with short black hairs, the last two segments creamy white, the apical one slightly darkened, the first segment is thickest at the apex. Legs with dark femora and tarsi; tibiæ pale, except just at their base, the basal half of the hind pair dark. Proboscis pale, darkened apically.

This bug very much resembles in appearance and in its method of working the Red Bugs of the genus *Heterocordylus* of America (see Bulletin 291. Cornell University, U.S.A., January, 1911, by C. R. Crosby).

The damage done by this species is identical with that done by the *Psallus ambiguus* and *Orthotylus marginalis* Reuter and others in Worcestershire and Kent. (Vide Report on Economic Zoology for the Year ending September 30th, 1911, page 27, 1912).

They may easily be controlled in the young stages by spraying with either paraffin jelly or a tobacco or nicotine soap wash.

The adults are difficult to destroy, and as the damage is done by the young forms, when the fruit is quite small, they should at once be killed. Observations have shown that the best time to spray for them, is just before the blossom opens as soon as the trusses of bloom are fairly well expanded.

Green Bug Damage to Apples.

These pests were again present in numbers in certain parts of England in 1912, and did considerable damage. From Suckley, Mr. Best wrote in June, that they had done no end of damage, especially to the young shoots, owing to the fact that he was

unable to spray through the inclement weather. On April 29th, Messrs. Caleb Lee & Sons, of Crockenhill, Swanley, wrote that " the green bugs you refer to are a very serious pest with us, especially if not tackled early in life."

The damage they have caused here has been not only to the shoots and foliage, but also to the fruit, which in many cases had a curious russety appearance last year. Mr. Emptage, of the *Fruit-grower,* wrote me in April, that he had been down to Crockenhill and found many Thrips full grown, and in smaller numbers, the Green Bug (*Orthotylus marginalis*).

There is no doubt that both Thrips and the Green Bugs cause similar injury, for I again traced the damage to the fruit in 1912, in one case to be solely due to Thrips, but in others, there was no doubt that the Hemiptera were the culprits and they undoubtedly were the chief cause of damage at Crockenhill.

In another letter, Mr. Sydney Lee wrote in April as follows: " It is shown that the attack begins very early by the young damaged leaves, and it is carried on until the apples are the size of a fairly large hazel nut. Many bushel of apples, were disfigured by scars last season, caused by the punctures of these Green Bugs.'

The apples most liable to attack are Bismarcks, Alberts, King of the Pippins, Beauty of Bath, and Derbys.

Woolly Aphis in Grease Bands.

In 1911, whilst trying numerous greases for fruit trees, I found that on some of my apple trees infested with the root form of the Woolly Aphis, the bands on June 7th on to June June 29th, were becoming covered with apterous *Schizoneura lanigera*.

As a result, I asked several growers to try this method of trapping the ascending ground form.

Colonel Honeyball, of Teynham, had Tanglefoot bands put on, and wrote on June 12th, that he "found Woolly Aphis coming up into the bands in great numbers."

Mr. Oswald Ellis also tried this method and when writing in March, said that this pest was going to be a serious thing with his young grafted trees unless the root form could be kept

down. He also mentioned that Worcester Pearmains seemed with him to be immune against the Woolly Aphis, whilst Bramleys take it badly. In some experiments, carried out in 1912, this is what I found. I failed to infect Worcesters in pots and in the open, whilst Bramleys took the disease at once.

Specimens of this aphis on Hawthorn were received for identification on November 5th, from the John Innes Horticultural Institute.

A special investigation is being made on this pest which will be issued separately.

A Phytoptid (*Epetrimerus* sp.) attacking Apple Leaves.

In 1911, apple leaves were sent from several localities, showing a somewhat obscure diseased appearance. A certain amount of Red Spider occurred (*Bryobia* sp.) but the damage did not resemble the marked appearance of Bryobia attack. The leaves were blotched with brown and dark spots, of irregular outline and did not show the usual marbling of Red Spider attack. In August, of this year, leaves were received from Sevenoaks, of several varieties of apples similarly attacked and beneath these were found short and thick—almost conical, yellow Phytopt mites belonging to the genus *Epetrimerus* and closely allied to, if not identical with, either *Epetrimerus armatus* of Canestrini found on *Cratægus oxyacanthus* or *Epetrimerus malinus* of Nalepa found on apples. The mites being found free on the under surfaces of the leaves, are easily destroyed by spraying with paraffin jelly.

CURRANT AND GOOSEBERRY ENEMIES.

The V-Moth (*Halia wavaria* Linnæus).

Although the caterpillars of this moth are well known to feed upon the foliage of the gooseberry and currant, there do not seem to have been any records of it causing any appreciable damage in this country.

In June, a communication was received with specimens of the V-moth from the Woburn Experimental Fruit Farm at Ridgmont, in Bedfordshire, complaining of the injury done

by the larvæ in that neighbourhood. It is a well-known pest in Germany to the gooseberry and red currant.*

The caterpillar is green with four waved yellowish white lines along the back, and a yellow line on the sides with some

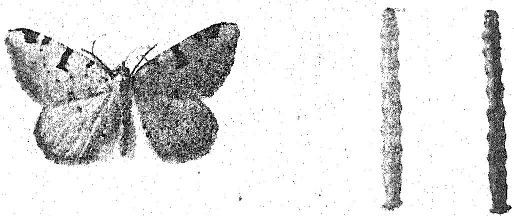

Fig. 4.
THE V-MOTH (*Halia wavaria*) AND TWO VARIETIES OF ITS CATERPILLAR

dark spots. It is a looper, having six green segmented legs on the first three segments, one pair of green sucker feet and an anal pair. When full grown, it is nearly an inch in length. They hatch out in April, and by the end of May, some are mature, a few go on until the middle of July.

When full fed they crawl to the ground and bury themselves in the soil and change to a brown pupa.

The moth appears in July. It measures about an inch-and-a-quarter in wing expanse. The front wings are grey, in some tinged with purple, with characteristic dark markings as shown in the photograph a V-shaped one being particularly, prominent. The markings however on the front wings vary very much. The hind wings are grey, with a central dark spot and traces of two or three dark marks on the inner margin.

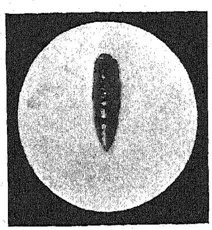

Fig. 5.
PUPA OF THE V-MOTH.

It is usually found in the evening flying about in gardens. From 1880 to 1900 I found it fairly common in gardens around

* "Die Schädlinge des Obst und Weinbaues," p. 19. Dr. L. Reh, 1911.

London, notably at Ealing, and at Kingston-on-Thames, and from 1887-1892, at Cambridge. It is also found at York, Charmouth, Nafferton, Nunburnholme, Brighton, etc., etc.

It is also known as *Fidonia wavaria.*

The larvæ can easily be destroyed by spraying with arsenate of lead.

The Currant Clearwing (*Aegeria tipuliformis* Clerck).

Attacked shoots of currants were received on March 7th, from Croydon. All the damaged shoots contained the larvæ of the currant Clearwing Moth (*Aegeria tipuliformis*), and it was said to be generally prevalent in the garden whence the shoots came from. It was also sent by correspondents from Woking, Brondesbury, Ipswich, and Norwich.

This Clearwing Moth but seldom seems to do any damage in commercial plantations in this country. With us it is essentially a garden pest, and this is notably so in suburban and town gardens. The moth likes the shelter, and is especially found in walled-in gardens, and then chooses any bushes that may be against a wall. Nevertheless, it now and then occurs in commercial plantations, but is easily controlled if the attacked branches are cut right back. Two cases were reported this year of its attack on the gooseberry and one on the ornamental Ribes. Currants bought by the College from Holland, contained numbers of the larvæ, which, as far as I know, is unknown in the neighbourhood of Wye naturally. The plants purchased this year may, unless due care is taken, be the means of introducing it to the neighbourhood.

A Currant Stem Girdler * (*Janus* sp. ?).

From Maidstone a report was received that the currants were being cut off at the tips in a very similar manner to that done by *Rhynchites* in apple and pear.

The attack could not be investigated, so the species causing the damage cannot be given.

The tops of the shoot wilt two or three inches from the tips and fall over or hang by a shred just as in the apple.

* "The Currant Stem Girdler." Bull. 126. Feb. 1897. Cornell Univ. Agric. Exp. Sta. Div. Entomology.

A hymenopterous larva was found in one shoot.

In America, Slingerland records a similar currant attack due to one of the Sawflies known as *Janus integer* Norton. So that it is probable this new attack in Britain is due to an allied insect.

I hope to investigate this matter this year.

The Currant Sawfly (*Nematus ribesii* Cameron).

This common plantation and garden pest was inquired after by Mr. Pain, of Sevenoaks, on March 28th, who wrote that it was doing great harm. Generally it was less prevalent than in preceding years.

It was also inquired after from Okehampton, Devon, where it was stripping the bushes in some gardens. Another correspondent wrote that soft soap and quassia had failed to kill it. Several reports have previously been sent in stating that the ordinary hop mixture will do so. Experiment made showed that soft soap and quassia will kill the larvæ as quickly as anything else if they are not about to moult, if they are it has no effect. On the other hand, a bush sprayed with arsenate of lead does so for the simple reason that it holds on the leaf and acts as a direct poison and not as the soap and quassia as a contact wash. With soap and tobacco the result is much more satisfactory than either soap and quassia or with arsenate of lead, for if it does not act as a contact wash it acts as a direct poison, and I am inclined to think as an indirect one by the plant absorbing some properties of the tobacco into its sap.

The Ash and Willow Scale (*Chionaspis salicis* Linn.) attacking Currants.

The very abundant grey scale seen on ash and willow, often in vast numbers, has to be added to the already long list of fruit insects. Its attack on Ribes in two places has to be reported.

Mr. Spencer Pickering sent specimens of currant shoots badly invaded by this Coccid from Woburn, in May, saying that some bushes were thickly coated with it. Later, more

specimens were received from the same locality from Mr. Neild.

During the same month I found it had appeared on red currants in my own garden, which was not surprising, as the ash poles in a surrounding wood were covered with it. Again, in July, I found an ornamental Ribes in the College gardens thickly coated with female scales, several branches having been killed by it.

Chio aspis salicis has a wide list of host plants. Besides being found on Ash and Willows, and Osiers, it occurs often in great numbers on the Alder, and is recorded from the Elm, Euonymus, *Viburnum latana, Acer campestris*, Privet, Birch, Broom, Guelder Rose, Lilac, Poplar, and *Vaccinium* in Europe. Fernald also gives *Cornus sanguinea Tilia parsifolia, Sorbus aucuparia* and on two species of *Sarothamnus* in America. The male and female insects can at once be told on the trees, the female scale is grey, of various shades, whilst the male scale is much smaller, and pure white, the latter, when they occur in numbers, as they often do, give the bark a white appearance. Both male and female scales may occur, however, intermixed. In winter the female scale will be found to have beneath it a number of dark red eggs. If these scales are rubbed at this time a distinct red fluid will be found to exude. The ova hatch from the beginning to the end of May, and the young larvæ which are red, crawl from beneath the scale and wander over the trees and bushes, giving the bark a distinct reddish tinge. Gradually they settle down and form the scale over their body, and in September lay their eggs. The males are winged and make their appearance in the later part of June and the first week in July. The red male lives only a few days, during which time many females are fertilised.

I found that it was easily controlled on currants by spraying with paraffin jelly in early June to kill the red larvæ, soon after they had crawled from beneath the parent scales.

Lime-sulphur wash at normal summer strength was also tried, but very few of the insects were destroyed. Lime sulphur wash was also used during the winter on a lilac attacked by it, but had little or no effect, whilst caustic soda at the rate of 2½-lbs. to 10 gallons of water and 1-oz. of soap readily destroyed them.

The Dark Green Ribes Aphis (*Aphis grossulariæ* Kaltenbach).

Frequent inquiries have been made during the last five years concerning a dark green aphis which causes the top of the shoots of gooseberries and currants, especially red currants, to become much stunted and with a dense tuft of terminal leaves. This is the *Aphis grossulariæ* of Kaltenbach, and is by far the worst Ribes species, not only on account of its form of damage, but also because it is not amenable to spraying. It can at once be told by its dark green hue, paler cornicles and by the tubercles at the sides of the abdomen.

It is found on the Ribes from the middle or end of May until July. As far as I have been able to trace, it appears on the currants as a winged female in May, and leaves the middle of July. Its life cycle has not been traced, but there is some reason for thinking that it may be the same as the Aphis found on the Guelder Rose (*Aphis viburni* Schrank).

I have now received this aphis from Cumberland down to Devonshire, and in all parts it seems to be equally destructive.

Nothing but actually dipping the attacked tips in tins of nicotine wash or paraffin jelly has any effect and as in gooseberries it frequently ruins the growth of young bushes, this has to be done. A full account of its structure and habits has been published in the *Journal of Economic Biology*.*

The Northern Currant Aphis (*Rhopalosiphum brittenii* Theobald).

This marked and handsome aphis was sent me by Mr. Britten of Lalkeld Dykes, Penrith, where it was very abundant on currants and gooseberries. The winged female is yellow to yellowish green, marked with black and with large swollen black cornicles ; so also is the apterous female.

Apterous females were sent me by May 4th, and in mid June the alate females. Mr. Britten found it commonest on the red currants, fairly common on black, and the same on gooseberries. It curls up the young leaves in a similar way to

* "The Aphides Feeding on Ribes," with descriptions of new species. *Journ. Eco. Biol.* Vol. VII., pp. 99-101, pl. I. fig. 3. F. V. Theobald.

Aphis grossulariæ Kalt., and *Macrosiphum lactucæ* Schrank The swollen black cornicles will, at once separate this Ribes Aphis from all others.

A full account of it will be found in the *Journal of Economic Biology*, Vol. VII., pp. 107-108, pl. I., fig. 2. (1912).

White Woolly Currant Scale (*Pulvinaria vitis* v. *ribesiae* Signoret).

Some very badly infested gooseberry and currant shoots literally covered with *Pulvinaria vitis* v. *ribesiae* were sent me by Mr. Lewis Levy, of Borden Hall, by Sittingbourne, on June 13th.

Some bushes in his plantations, he said, were smothered by the pest. Later I visited his plantations, and although the bushes had been grubbed and burned, there were still traces of it in one plantation. The attack was so severe that the bushes were practically killed. I am told this was the first year it had been seen. One bush I examined, that had a considerable number still on it, had the twigs dying off.

Whether parasites would have eventually killed the pest off or not, was of little moment, as the attacked bushes were of no use and any parasites on them were naturally destroyed with the pest—in any case, and many of the old "scales" showed parasite holes—yet they had not saved the bushes from destruction.

Such an insect as this is not likely to cause any severe loss in our clearly kept plantations of to-day. It is too prominent to be allowed to increase. Grubbing and burning usually is the practice when it shows itself, so one has little chance of making any observations.

The Brown Scale (*Lecanium persicae* v. *sarothamni* Douglas).

The last two years have witnessed a great increase of the well known and widely distributed Brown Scale of the Currant and Gooseberry, the *Lecanium persicae* v. *sarothamni*.

Writing from Linton, in June, Mr. Clive Murdock said that the scale was smothering his bushes to such an extent that they were stunting the growth and the fruit.

Colonel Honeyball, of Teynham, had one of the worst attacks not only on gooseberries, but also on red currants. The wood in some specimens sent was so thickly crowded with old and young insects that little or nothing of the wood could be seen and the few stunted leaves, and the box they were sent in was sticky with " honey dew." The amount of " honey dew " caused by this pest in this case was so great that according to Colonel Honeyball, the berries when picked for market, were dripping with it, and spoiled, and similarly with the red currants. A slight stickiness may often be found when this coccid abounds, but I have never seen the copious flow of exceeding sticky fluid, such as occurred in this attack, before.

Messrs. King Smith, of Platts Farm, Borough Green, Kent, also suffered severely from this insect, and in consequence, I visited their plantations in April. Some of the bushes had been sprayed with lime-sulphur wash (Berger's preparation), some with Voss's Woburn Paraffin Wash.

The bushes generally showed a great deal of the immature females on them, in some places they were thick with the young red females.

Growers generally look upon the old brown exuviae as their enemies and after spraying, find they may have fallen off in early spring, and imagine they have destroyed the pest ; the small immature females escape their notice.

Winter is the best time to attack this foe, and there is no doubt that the strong caustic soda and soap wash is the most effectual.

Lime-sulphur wash at Platts Farm had undoubtedly destroyed at least eighty per cent. of the immature females, which can at once be told by their losing their bright reddish coloration. After caustic soda or lime-sulphur spraying they become a dull brown to grey, and can easily be seen with a lens to be dead.

Caustic soda has a great advantage over lime-sulphur in this respect, for it burns off the rind under which the young females love to hibernate, and as far as I have seen, the lime-sulphur wash does not touch them in those positions. It therefore only partially does its work.

If treatment has been left too late for winter spraying, then the use of paraffin jelly must be relied on, care being

taken to make it fit in with, if necessary, an attack of Red Spider.

Growers have for too long neglected this insect, which does not make its effect felt at once, but which in a couple of years if the weather is propitious, will do endless harm, not only to the crop of the year, by spoiling the colour of the berries, and covering them with a sticky mass and black fungus or smut fungus, but also directly crippling the bushes.

Gooseberries and red currants seem most prone to its ravages, but it will occur on blacks and whites now and again, and does similar damage.

Green Bugs and Springtails on Currants.

Typical damage caused by the two culprits mentioned above, to black currants, was sent by Mr. Harvey Bickham, of Ledbury. Both Green Bugs (*O. marginalis*) and Yellow Springtails (*S. luteus*) were present. One acre out of six was badly affected, and it was a most notable fact that the plantation on a piece of arable land adjoining was quite free from both pests.

Big Bud (*Eriophyes ribis* Nalepa).

Specimens of currant buds were sent by Mr. Ballard, of Stockton, Worcester, in April, and by Mr. Harvey, of Belmont, Stanford, Hythe, in the same month. Both cases showed bad infestation.

Samples for examination were also received from Norwich and Exeter.

Some bushes cut down to ground level in 1911 had the tops heavily dressed with hot lime and the ground around them. The young shoots came away quite clear of Big Bud, which is not usually the case. Further trials are being made with this treatment and will be reported next year.

There is no doubt that large numbers of the Eriophyes fall to the ground and this alone can account for the new shoots coming up often very badly infested. Whilst ordinary lime has been found to have no effect, it appears that hot lime put on fairly thickly either destroys or checks them, whilst in the soil.

CHERRY ENEMIES.

The Bark Beetle (*Scolytus rugulosus* Ratz).

The Bark Beetle (*Scolytus rugulosus*) was sent in July, infesting cherry trees. This Beetle is most prevalent in plum, now and then it attacks apple, but I have not heard of it before doing any damage to the cherry.

The Cherry Aphis (*Myzus cerasi* Fabricius).

This Aphis was reported as doing a good deal of damage at Hallatron, Bristol, in May, speaking generally it was not so abundant as usual.

PEAR ENEMIES.

The Pear Leaf Curling Midge (*Cecidomyia pyri* Bouché).

Reference to this Midge was made in my book on Fruit Pests* and an illustration of the damage done to the foliage given (Fig. 230, p. 350).

It was recorded there, that it had never been complained of, but that it had been sent for identification and mention was made that it might so increase as to become a pest.

This has proved to be the case, as it has so increased in one locality near Maidstone, that it has already done considerable harm. The same grower reported again at the end of 1912, that there had been a bad attack. A few sorts of pears seem to resist the attack, but on the whole, they all seem to go under. The marked rolling up laterally of the pear leaves, at once enables us to identify the attack. Usually both sides of the leaf are rolled, but sometimes only one side is attacked. The presence of the small, creamy white, footless larvæ in the rolled up portions definitely settles the cause of injury. Attacked leaves lose their vitality and soon turn black when cut off the trees. To rear the flies, one has to leave the infested leaves on the trees until the maggots are nearly full grown, as they cannot be transferred from one leaf to another.

* "The Insect and other Allied Pests of Fruit," p. 350, 1909.

The larvæ and much damaged foliage were sent me early in July, and at that time the larvæ had commenced to leave the foliage, and entered the soil to pupate. From four to twenty larvæ were counted in various leaves examined. The flies commenced to hatch out on August 17th, and went on appearing until August 27th. They were very active during the day-time. The colour mentioned in "Insects and other Allied Pests of Fruit" was brown, but when alive these small midges have a red abdomen.

The general appearance is as follows:—The *female* (Pl. VII. A.) has a blackish head with rather short pale golden hairs and some small, almost flat pale golden scales at the sides; the palpi are composed of four segments, the third and fourth longer and thinner than the other two, pale brown;

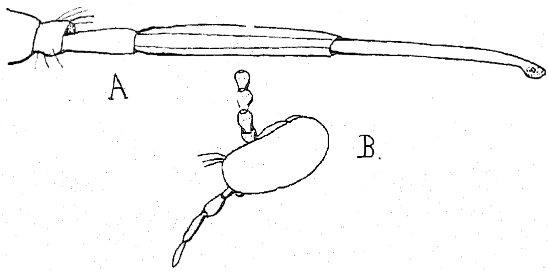

Fig. 6.
OVIPOSITOR A, AND HEAD B, OF *Cecidomyia pyri*.

antennæ dark brown composed of fourteen segments; the neck reddish-brown to testaceous. Thorax black with three lines of golden-yellow hairs; scutellum deep reddish in some, brown in others, or even pale reddish.

Abdomen bright deep red, with darker transverse lines above, formed by small brown flat scales; lateral hairs and a few ventral ones dark brown. Ovipositor (Fig. 6. A.) pale, slightly dusky at the apex, which is notched, and telescopic. Legs dark brown, the tarsi somewhat darker than the rest. Wings smoky-grey, yellowish at the base, with black costal and first long vein, the latter almost straight and joining the costa at its apex. Halteres pallid, yellowish at the base.

The *male* is similar in colour to the female, but the legs are grey with dark brown tarsi. Thorax black in the middle,

reddish to reddish yellow around the sides and on the pleuræ above. Genital claspers dark Antennæ of fifteen segments. I found one female laying her eggs in a young tender leaf before it unfolded, inserting her telescopic ovipositor far into the fold.

This insect is thus apparently double brooded.

Winter is passed in the pupa stage, in the earth.

The remedy suggested was to spread vaporite beneath the trees when the larvæ were falling to earth; the vaporite at once destroyed them in pot experiments.

I have also found it in several nurseries.

The Pear Midge (*Diplosis pyrivora* Riley).

The damage done by this—the worst of all the pear pests—was recorded from Pond Farm, Old Malden, Surrey, in May. It was general in its attack, but Williams were the most affected.

Several fresh references have been made to the benefit of keeping chickens in the plantations infested with *Diplosis pyrivora*.

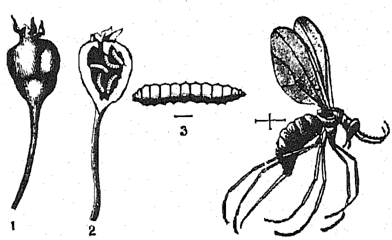

Fig. 7.

THE PEAR MIDGE.

1. Pear stunted and malformed by the larvæ within it.
2. Section of pear with larvæ. 3. Larva, much magnified.
4. Female fly, much magnified.

Lines show natural length of fly and larva.

(From U.S.A. Dept. Agriculture.)

I have found that where as reported last year I sprayed the grass beneath the trees, when the midges were on the wing, that no midge has appeared this year (1913).

Evidently the great numbers destroyed in that way has stamped out the insect.

This might be worth following out where large perry pears are grown on grass land, but exact observations must be made, as the midges only last a short time, and it must be done when they are on the grass, that is on dull days or in the early morning.

The Pear Leaf Blister Moth (*Cemiostoma scitella* Zella).

Two cases of damage caused by the larvæ of the Pear Leaf Blister Moth (*Cemiostoma scitella*) were recorded in 1912. In one case, some wall pears were stated to be badly attacked at Rodmersham, by Mr. A. T. Thomas, on July 22nd.

The other case was at Dunham Magna, Swaffham, Norfolk, the Reverend Canon Blake Humphrey writing that it was very abundant on his pears on the 17th of September.

Although this small Tineid Moth may be found in its larval condition, both on pears and apples in the open, it seldom does any harm except on trees against walls.

Spraying with tobacco wash carried out last year proved of considerable benefit. There is no doubt that the nicotine and other constituents of the tobacco soak into the blisters caused by insect larvæ on leafage and have a very injurious effect on the larvæ feeding within.

The Pear Sucker (*Psylla pyricola* Först).

At last, traces of this very harmful insect in America have been found doing damage in this country.

On April 29th, I noticed some traces of pear blossom dying and brown at Boughton, and found numbers of larval *Psylla*, which I at first mistook for the Apple Sucker (*Psylla mali*). Later, the well marked features of the Pear Sucker (*Psylla pyricola*) showed themselves (Fig. 8).

In July, Mr. Lake sent specimens from Mortimer, Berks, saying they were found on the leaves of some Beurre Bachshei espaliers, but were not bad. This insect is well-known to occur in Britain, but it is by no means common and has not been noticed on commercial fruit before last year that I am aware of.

The Apple Sucker was not nearly as bad fifteen years ago as it is now. In fact, in some districts, very few could be found where millions exist at the present time.

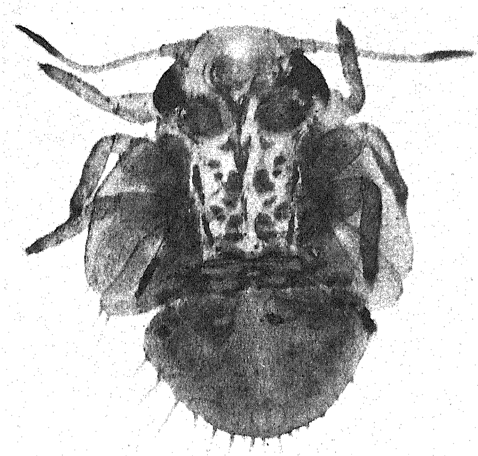

Fig. 8.
PEAR SUCKER (*Psylla pyricola*).
Nymph greatly enlarged.

As the Pear *Psylla* is harmful in America, and exists with us, it is quite possible that here it may increase also, and become another enemy of the pear.

The Pear Leaf Blister Mite (*Eriophyes pyri* Nalepa).

This mite, which has now taken a firm hold on pears, was reported from Sidmouth, Devonshire, by Mr. F. Potbury, who wrote that some trees against a wall were badly infested in May.

Just as with the Pear Leaf Blister Moth (*Cemiostoma scitella*), so with this Eriophyid mite, wall trees are mostly attacked, but that this is not always the case, is shown by the fact that it has been reported many times during the last four years as attacking trees in the open in commercial plantations. Fortunately, it is comparatively easy to control, by winter

spraying with lime-sulphur-soda-salt wash and in spring with paraffin emulsion.

One tree sprayed with the ordinary lime-sulphur wash had the pest considerably reduced but its effects are not nearly as great as those of the lime-sulphur-soda-salt wash, which I should strongly advise in bad cases of this attack.

PLUM ENEMIES.

Otiorhynchus Weevils.

Damaged caused by *Otiorhynchus picipes*, the Clay Coloured Weevil, was reported by Mr. W. Voss, in May, who wrote that "they were attacking the fruit trees, especially plums and roses, of a correspondent, eating out the young shoots and buds, working only of a night." Messrs. White and Co. of Beltring, Paddock Wood, Kent, also sent specimens, saying that they were "nipping off the tips of young apple shoots," and Messrs. Wood and Son, of Wood Green sent specimens of both *O. picipes* the Raspberry Weevil and *O. sulcatus*, the Vine Weevil, stating that "they were doing considerable damage to peach and plum trees."

During a recent visit to Botley, in Hampshire, I found that the larvæ of the *Otiorhynchi* are very harmful to strawberries in that district. The larvæ live right in the central part of the rootage and so cannot be got at except by bi-sulphide of carbon injections. They work so ravenously, that they soon k ll the plants. In one case, they had appeared in numbers on some new land that had been heath land.

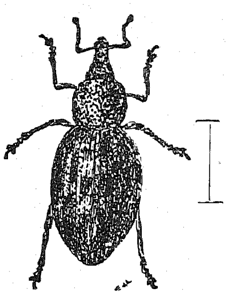

Fig. 9.
THE RASPBERRY BEETLE.

The white larvæ of all three injurious fruit *Otiorhynchus*, namely the Raspberry Weevil (*O. picipes*), the Plum or Red Legged Weevil (*O. tenebricosus*), and the Black or Vine Weevil (*O. sulcatus*), unfortunately all feed on a great variety of plant roots.

They were sent me last year from the roots of cyclamen and maidenhair ferns, from hop roots, currant and

strawberry roots, asparagus and wallflower roots. They also may be found on the roots of various bushes and weeds in the open and also on clover and lucerne.

In strawberries, they were complained of in the Hampshire district as girdling the crowns of the plants in numerous cases; as many as a dozen larvæ may often be found at a single plant.

All three of these weevils I find exist, both as adults which hibernate amongst grass, etc., around posts and in the soil, and also as larvæ on the roots during the winter.

The adults do much harm by gnawing the young grafts of apple and pear, but do not seem to cause any serious harm to strawberries. Roses were also reported as being eaten by them three times during the year, two cases in the open, one under glass.

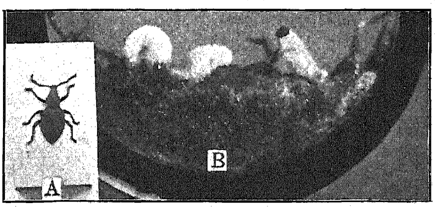

Fig. 10.

A *Otiorhynchus picipes*. B. LARVÆ.

The Raspberry or Clay Coloured Weevil, also called the Cherry Bug in parts of Worcestershire, on account of its eating the cherry foliage, is apparently the most widely distributed and most harmful of the three species.

Great numbers occurred at Wye in 1911 and 1912, and did considerable damage to young grafted trees. The Beetles were trapped by placing pieces of sacking on the ground beneath which they shelter during the day. In spite of very large quantities being collected, the pest still persisted and to keep them off the trees they were grease-banded; most greases will not hold these hardy beetles, but I found that very few were able to cross a three-inch band of Tanglefoot.

There are certainly two broods of this insect. Beetles commenced to appear at Wye in March, most of these were hibernators, but here and there a fresh, and in some cases a

quite immature beetle was found, and by April many were hatching out of the soil, and these continued until June. At the end of July and in August, a fresh lot of beetles appeared, evidently the second brood. These did little damage, some kept under observation laid eggs, others lived on through the winter. In the Wye district, I watched starlings hunting for the beetles in March, and one shot contained no less than forty of these insects.

That the starling is a great enemy of this *Otiorhynchus* we can see from the following records taken from Mr. Wm. McGowan's tables on the food of the starling from February 1912, to January 1913.

In February	60	birds	examined	contain	5	*Otiorhynchus*.
,, March	46	,,	,,	,,	10	,,
,, April	99	,,	,,	,,	115	,,
,, May	82	,,	,,	,,	21	,,
,, July	17	,,	,,	,,	4	,,
,, August	7	,,	,,	,,	14	,,

In addition to this, some of the bird crops were full of fragments of beetles of which *Otiorhynchi* formed a considerable portion, especially in April and August.

Prevention and Treatment.

Trapping the beetles under pieces of sacking and collecting them during the day must do a great deal of good, but as the weevils seem to hatch out over a considerable period, it must be persisted in to have any effect, as the beetles cannot fly.

Vaporite I have always found to kill the larvæ, but it is doubtful if it would be of any use in the case of strawberry attack, or in hops, where the maggots get right into the centre of the plant.

The land may be cleared to some extent by rotation, if this is done it should be remembered that the larvæ will not attack potatoes and they are not known to feed upon mangolds or carrots.

Spraying with arsenate of lead is found to kill them and also the Leaf Weevils (*Phyllobius*).

The Figure-of-Eight Moth (*Diloba cæruleocephala* Fab.).

Mr. Neild, of the Woburn Experimental Fruit Farm, sent the larvæ of the Figure-of-8 Moth (*Diloba cæruleocephala*) to name on June 7th, the specimens being nearly full-grown and stated that they were in considerable numbers on fruit trees in that locality. It usually occurs on plum, cherry and hawthorn.

The Plum Fruit Sawfly (*Hoplocampa fulvicornis* Klug).

This Sawfly, like the Apple Fruit Sawfly (*Hoplocampa testudinea*), seems to still be on the increase in the South and Midland counties. It is also a serious pest in Westmorland amongst the damsons.

Writing from Ombersley, Droitwich, Worcestershire, Mr. H. Gardner said "that where there are a few plums left by the frost, every one is bored into as those sent. This insect has done a lot of damage here for the last two or three years."

Mr. Oswald Ellis, of Bramley, stated that he had persisted in handpicking for this pest, which appeared with him five years ago, and that enough always seemed left to give a bad attack next season.

Mr. Rymer Roberts, of Windermere, wrote concerning the abundance of this insect amongst the damsons in that district.

The Plum Aphis (*Aphis pruni* Reaum).

The only case reported of damage by Plum Aphis (*Aphis pruni* Reaum), was from Hallatrow, Bristol, in May. This blight is so well known now that it is but seldom inquired after.

It can easily be controlled by spraying with thick lime and salt, in March, or by autumnal spraying with paraffin jelly to prevent egg laying. Spraying when the blight has once got a firm hold and the leaves are curled is of little or no avail, and is quite waste of money.

Messrs. King Smith, of Platt Farm, Borough Green, have found considerable benefit to plum and apple by autumnal spraying to prevent the two leaf curling aphides of those fruit trees.

RASPBERRY ENEMIES.

The Raspberry Shoot Borer (*Lampronia rubiella* Bjerk).

A single case only of this pest was reported in 1912. Dr. Durham, of Eign Hill, Hereford, sent some badly damaged shoots on 21st of April, saying that in one of the workmen's gardens there, nearly every shoot in his bed of raspberries had been destroyed by the enclosed insects.

The process of greasing the canes in February or early March, seems to have proved itself quite successful in dealing with this pest.

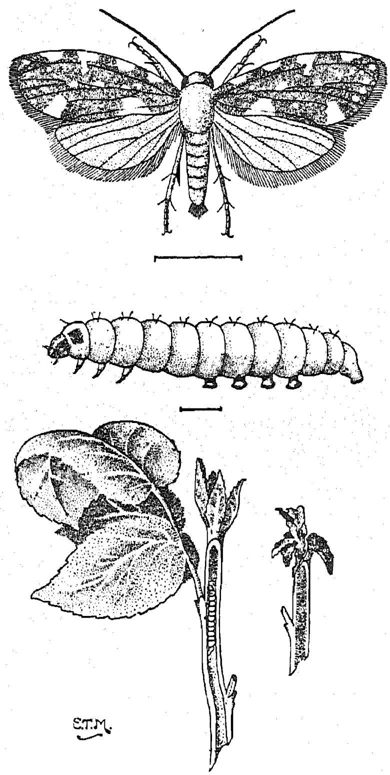

Fig. 11
THE RASPBERRY MOTH.
(*Lampronia rubiella*).
Adult larva, and damaged shoots.

The Raspberry Beetle (*Byturus tomentosus* Fabricius).

This pest was reported as being very harmful at Ash, near Wrotham, by Mr. G. Day, in May, and generally it seems to have caused the usual loss especially to loganberries.

A New Dipterous attack on Raspberries.

A quite new attack to me on raspberries, was brought to my notice by Mr. G. D. Lake, of Mortimer, Berkshire, on June 1st.

The top of the shoots die away as shown in the photograph and inside is found a single dipterous larva, tunnelling in the pith. (Fig 12 A).

During the past year, I found a similar insect causing just the same appearance on brambles, at Wye. Unfortunately, these have died. The shoots for about five or six inches at first flag and then become constricted and bend over, eventually dying and turning brown.

The maggot generally resembled those of *Phorbia.*

A similar attack has been recorded in America.

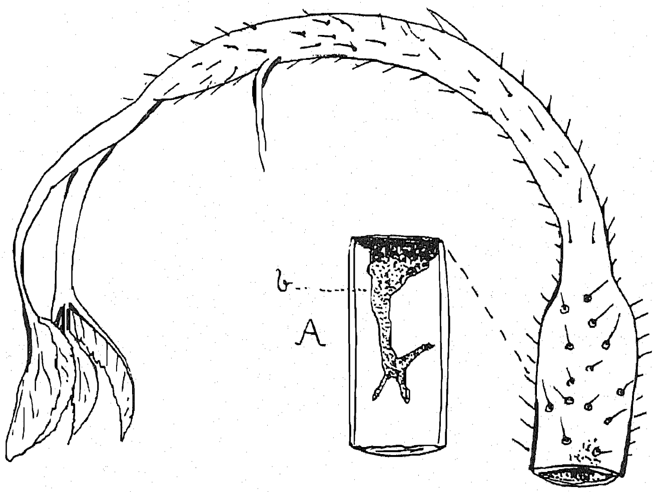

Fig. 12.

Raspberry Shoot attacked by a Dipterous Maggot.

A.—Section showing tunnel.

The larva was shiny, creamy white, semi-transparent; the posterior part of the body tinged with orange; the two dorsal trachea showed plainly through the skin; mouth hooks black; cauda truncated, with two yellowish hook-like stigmatic processes.

It seems that this maggot only attacks the new shoots. In some cases the stem attacked turns dull deep blue and later may break off. At the breaking point, the shoot seems to have been girdled by the larva within it.

On one bramble shoot, I found an egg during the later part of April, white and placed near the tip of the shoot in the axil of a small terminal leaf. The larva, which hatched in two days after it was found, soon entered the shoot, leaving a small but distinct scar and there the tissue turned purple. The larva then tunnelled downwards making an irregular passage which increased in size in the pith, for a distance, in one case, of five inches, and in another of only three. The larva later completely girdled the shoot, just under the skin, and here the shoot suddenly contracted. It remained feeding in the pith at this point for some days and the part above shrank as seen in the photograph.

Then the maggot continued its passage down the shoot, nearly to the ground, and there it pupated.

The purparium was brown and of the normal type.

Pupation took place in July, Unfortunately, the fly did not hatch.*

In America, Slingerland† describes a similar attack, answering in all ways to the one here produced by a species of *Phorbia*, which hatches in April, and states that there is only one brood in the year.

Whether this insect increases or not on the raspberry, and also goes to the loganberry we cannot say, but now it has appeared on the former fruit, it may do so just as other nature bramble feeders have done.

It would be well for growers to keep an eye on this insect and cut off well below the flagging area of the attacked shoots.

The American species has a natural enemy in the form of a small hymenopterous parasite known as *Idiasta incompleta* Prov.

There is no doubt that the one attacking our raspberries is a native species, as I found it on brambles in two places, at Wye.

* Whilst going to press the fly has been sent me and is being named by Mr. Austen (*vide Addenda*).

† The Raspberry Cane Maggot. Bull. 126, p. 54. Feb. 1897. Cornell Univ. Agri. Exp. Station, Div. Entomology.

STRAWBERRY ENEMIES.

The Large White Plume Moth (*Aciptilia pentadactyla* Linn.).

The larvæ of the Large White Plume Moth (*Aciptilia pentadactyla* Linnæus) were originally recorded as feeding on the strawberry, by Collinge, in 1905, when they were unusually numerous in Worcestershire, Warwickshire, and Staffordshire. ("Report on Injurious Insects and Other Animals observed in the Midlands during 1905," p. 36, 1906.)

It occurred in Essex, in 1912, near Chelmsford, feeding on the same plant and also was found at Wye, where it was very abundant, doing the same.

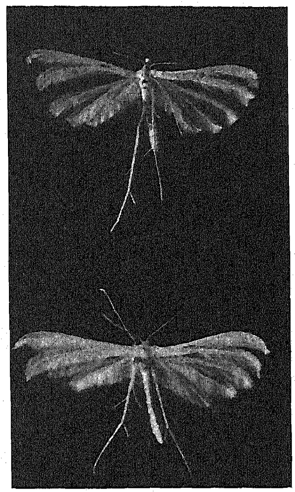

Fig. 12.
THE LARGE WHITE PLUME MOTH (*Aciptilia pentadactyla*).

Its normal food plant is the bindweed (*Convolvulus arvensis*) and it appears to especially leave this host plant for the strawberry where beds are not kept clean. The moth (Fig. 12) appears in June and July, the larvæ in May, on into June; they are hairy, greenish, tinged with white, with a green line along the back and a black spot on each segment. The pupa is slightly hairy and is found attached to the leaves.

The Black Anthonomus (*Anthonomus rubi* Herbst).

This Weevil which Fenoulhet and myself have already recorded as being very harmful to strawberries was inquired after by a number of growers in the Swanwick district, where it is known as the Elephant Beetle.

The damage to the blossom in some seasons appears to be serious. Just as with the Apple Blossom Weevil so with this kind; the females lay their eggs in the unopened blossoms and there the white footless larvæ live and pupate. But there is

this difference that the Black Anthonomus pierces the strig of the blossom and causes it to fall over as shown in 1 and 8 fig. 14.

The beetles hibernate under any shelter they can find, and may be found in an active state from the middle of April onwards until the strawberries have finished blossoming. They are also found on the raspberry, blackberry and loganberry where they work in a similar way, but do not cause so much loss. They have also been found on roses.

As soon as the weevil has laid its egg in a flower bud it descends to the strig and then, as described by Fenoulhet, forces its rostrum into the delicate stem, severing through the vascular bundles. This may be just below the blossom-bud or a quarter of an inch down. Many blossom-buds may be killed by a single beetle. The infected buds soon shrivel up and fall over, later becoming brown and many fall to the ground.

The larval life extends over a period of three to four weeks and the pupal life seven to eight days.

The beetles, on hatching out, feed upon the tender leaves and shoots but do not do any appreciable amount of damage.

The weevil is about one eighth of an inch long, unicolorous black, covered with even scanty grey pubescence; the rostrum is long and slightly curved (*vide* 5, fig. 14). It has been recorded as injurious from Sandway, Maidstone, Borough Green, Kent; Wye, Kent; Penn, in Buckinghamshire (Fenoulhet); Herefordshire.

The attack on strawberries seems to me to mainly come from raspberries and brambles.

I have found it may be easily collected by jarring in raspberries, and where we have raspberry plantations near strawberries, it is advisable to do so because at present there seems no reasonable way of fighting it in strawberry beds.

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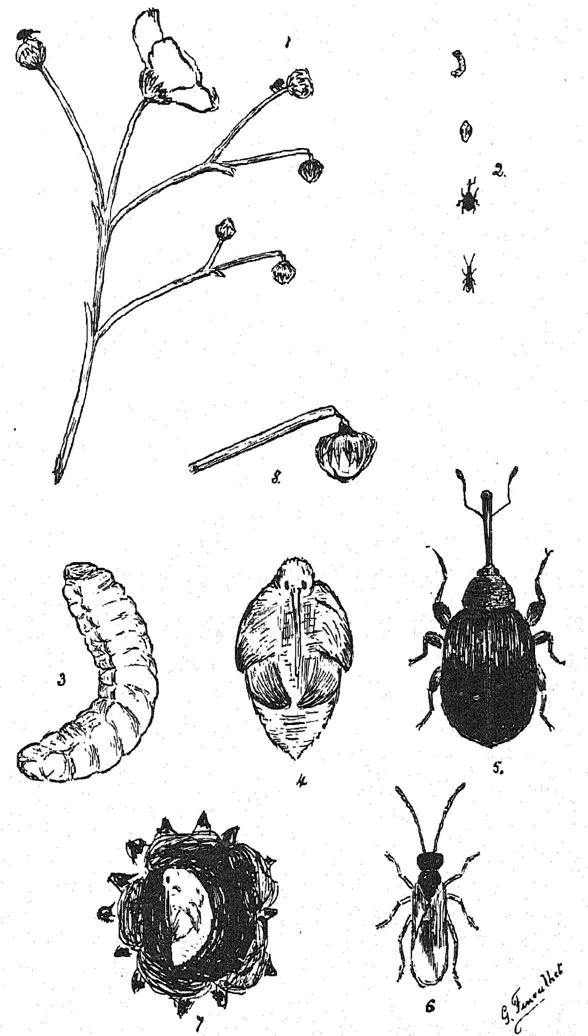

Fig. 14.

Anthonomus rubi Herbst.

1. Beetles at work on Strawberry blossoms. 2. Stages life-size. 3. Larva. 4. Pupa. 5. Adult. 6. Ichneumon parasite. 7. Pupa in blossom. 8. Damaged blossom.

The Delicate Strawberry Aphis (*Myzus fragariae* Theobald).

This very delicate green aphis, which is often almost transparent was sent to the Board of Agriculture from Hounslow in March. I found it again in great abundance in some strawberry houses at Rudgewick, in Sussex, in May. It first seemed to occur only under the delicate young leaves, later the larvæ, apteræ, and nymphæ swarmed up the leaf-stalks, and in May, I found them at Rudgewick all over the plants. Nymphæ first occurred on March 29th, many on April 4th, and winged females commenced to appear on April 16th. The colony sent by the Board kept on producing alate broods every now and again until June when the plants unfortunately were allowed to dry up.

The appearance of these insects on the pot plants, was almost like fine drops of dew when the light was shining on them. They are fairly easily kept down under glass by tobacco fumigation. The fine capitate hairs on these delicate insects are very marked. It is related to *Myzus ribis* Linnæus, found under the red blisters on currant leaves, but the sensoria on the antennæ of the alate female, are markedly different and they are of a very much paler green and more delicate appearance. An allied species occurs on strawberries in America, but I think it is distinct.

Apterous Viviparous Female.—Very pale green, often semi-transparent. Head, thorax, and abdomen covered with capitate hairs. Antennæ as long as the body; basal segment rather large, with a thick blunt swelling on the inner side; second segment small; third long, not quite as long as the next two, which are equal; the sixth longer than the fourth and fifth; the first with several, the second with two large and some small capitate hairs, the third with one or two on the inner side. Cornicles long and thin, almost transparent, with faint imbrication; projecting some distance beyond the cauda. Cauda pallid green, with two pairs of lateral hairs and a median apical one. Legs pallid green, almost transparent; tarsi slightly dusky; femora and tibiæ with capitate hairs. Eyes blackish.

Length, 1-1.5 mm.

Winged Viviparous Female.—Head dark brown; antennæ dark brown. Prothorax pale yellowish green; mesothorax with dark brown median area. Abdomen pale yellowish green, with a dusky patch on the apical half, and a few small dusky spots on the basal segments and dusky lateral spots. Legs pale yellowish green, apices of femora and tibiæ dusky, tarsi dark. Cornicles pale yellowish green. Wings with smoky black veins and smoky black stigma. Capitate hairs scantier than in the apterous form, four on the front of the head, some on the two basal antennal segments, and short ones on the body, the heads being only slightly swollen. Third antennal segment with 32-36 sensoria disposed all along it, fourth with 5-8 sensoria; third segment about as long as the fourth and fifth; sixth a little longer than the fourth and fifth; cornicles showing faint imbrication, not projecting beyond the pale green cauda, which has two pairs of lateral hairs and one median apical one. A marked papilla on the under wings with five curved apical bristles.

Length of body, 2-2.5 mm.; of wings, expanse, 7 mm.

Food-plant.—Cultivated strawberries.

Habitat.—Hounslow, Middlesex, and Rudgewick, Sussex.

Observations.—Described from a colony sent me by the Board of Agriculture, in March. At first the apterous females only occurred under the leaves; later they and the nymphs swarmed up the leaf-stalks as well. Pupæ occurred on March 29th, many on April 4th, and winged females commenced to appear on April 10th. The apterous females resemble *Myzus ribis*, but the alate forms are very distinct, having green cornicles and different abdominal ornamentation. Some of the alate females appear to have five, some three, curved bristles on the papilla on the under wings. I also found it swarming on hothouse strawberries in May, at Rudgewick and doing some damage. A succession of winged broods kept on appearing until mid-June.

A New *Macrosiphum* on Strawberries.

Amongst some strawberry Aphides which were found doing harm at Hounslow and sent me by Mr. Rogers of the Board of Agriculture were found a certain number of a species of a green *Macrosiphum*. This species does not agree with any so far

found on strawberries and will be descr'bed elsewhere as a new species. The specimens were received on March the 10th It is being described under the name *Macrosiphum Rogersii.*

The Small Snake Millepede (*Blanjulus pulchellus*).

From Cullompton, Devon, the Small Snake Millepede (*Blanjulus pulchellus*) was sent with a note that the ground was infested with them and that they had spoilt a whole crop of strawberries and that they were also attacking rhubarb roots and had quite spoilt beans and peas and that generally they were most harmful.

These Myriapoda can be cleared out by either trapping with pieces of mangold or potatoes, and by the application of vaporite to the soil. I have always found them worst in soil deficient in lime and consequently a good dressing of lime will also clear the ground of much of this pest.

MISCELLANEOUS FRUIT ENEMIES.

Fruit Damaged by Earwigs.

There is a common belief that earwigs are purely carnivorous. This is far from being the case, as they are often harmful to the leaves and blossom of plants. Great damage was caused by them to hops in Kent, in 1895.

They have frequently been recorded in the horticultural journals as damaging flowers and there is not the least doubt that they damage soft fruit, such as peaches and nectarines.

Writing from Saxmundham, Suffolk, Miss Solomon reported that Earwigs had done great harm to the fruit of all kinds there, during the year.

They were also reported once in 1912, as eating apples in Kent.

Another bad habit recorded during the year, concerning them, is that they attack Lady Bird (Coccinellid) larvæ.

Writing in July, Mr. Mawley, Secretary to the National Rose Growers' Association, stated that Earwigs were eating the "niggers" or larvæ of the beneficial Lady Bird Beetles. (Coccinellidæ).

In consequence of this communication, a number of "niggers" were later collected off the hops and placed with a

dozen *Forficula auricularia* in a mouse jar. For several days the Earwigs took no notice of the "niggers," but at the end of seven days, no less than six niggers had gone in one night, and by the end of two weeks all the "niggers," some twenty odd had been devoured.

It is possibly only an exceptional item in their menu, but is worth recording.

With regard to the destruction of Earwigs, there is no doubt that both the starling and the rook do inestimable good in keeping them in check.

The following records are taken from Mr. W. McGowan's tables (not yet published) on the food of the starling, from January 1912, to January 1913.

In January, in 60 starlings, 27 Earwigs ; in March, in 46 ; in April, 99 birds, 107 Earwigs ; in June, 45 birds, 43 Earwigs ; in November, 14 birds, 72 Earwigs.

Beetle Mites (*Oribatidae*).

These Acari were reported from Reading on the 29th of September as swarming in an orchard, the grower asking how best to destroy them.

It was pointed out that these Acari are beneficial in that they feed upon the green algae, lichens and canker fungus fruits.

ANIMALS INJURIOUS TO HOPS.

The Peacock Butterfly (*Vanessa io* Fabr.) on Hops.

I am not aware that the beautiful Peacock Butterfly (*Vanessa io* Fabricius) has been recorded as feeding on the hop.

It was reported as doing so by Mr. J. D. Laye, of Cherry Gardens, Goudhurst, Kent, in July last year. Numbers of the caterpillars were sent which were infesting some hills in the middle of the garden, one hill had all the leaves eaten off before the culprits were noticed.

Two hills were also found badly eaten by these caterpillars at Boughton, in the same year.

It is unlikely, however, that this insect will cause any serious damage as it nowhere appears in very large numbers, although widely distributed and generally common in Britain, but becomes rarer in the north. A greater number than usual were noticed in Kent, in 1912, and this may have been so in other parts and thus account for its appearance in the hops.

The usual food plant of the Caterpillar is the nettle.

The beautiful butterfly (Fig. 15a) appears on the wing from the middle to the end of July, and is seen on into the autumn. Many survive the winter, hibernating in any sheltered nook, just as does the small Tortoiseshell Butterfly (*Vanessa urticae*) and the rarer Large Tortoiseshell Butterfly (*V. polychloros*) which in some years has appeared in numbers on cherry trees in Kent.

The caterpillar is gregarious, and can at once be told by its black spiny body, spotted with white and its red hind legs (Fig. 16).

The young larvæ are devoid of the spines.

The eggs are laid in groups on the leaves in May. When mature, the larva suspends itself head downwards, attached to the leaf or any object near by a pad of silk.

The chrysalis which has two triangular divergent horns on the head, and a short spine on the middle of the thorax, and six subdorsal spines on each side of the abdomen varies in colour, some are grey with a metallic lustre freckled

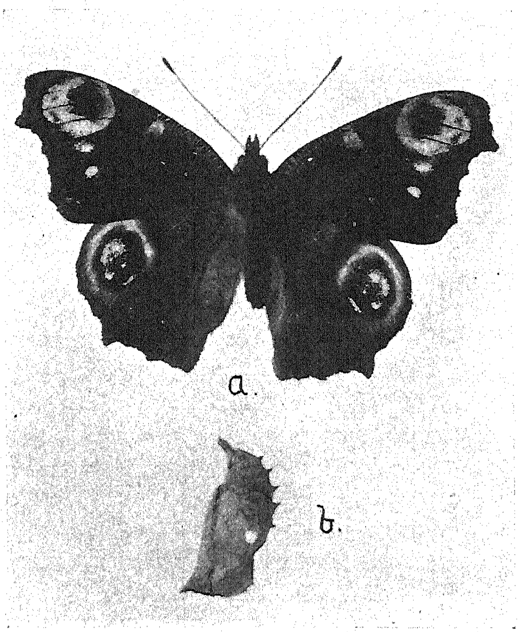

Fig. 15.

THE PEACOCK BUTTERFLY (*Vanessa io*) *a* AND PUPA. *b*.

with smoky black, others pale greenish yellow freckled with black and some brilliantly gilded all over. Those from the hops at Goudhurst and Boughton, were all of the later type.

Albin found gilded pupæ which produced small ichneumons but all those I had hatched out, none were parasitised. The pupal stage lasted from fourteen to nineteen days.

Some caterpillars transferred from the hops and fed on nettles produced only stunted and deformed butterflies, although the chyrsalids were quite normal.

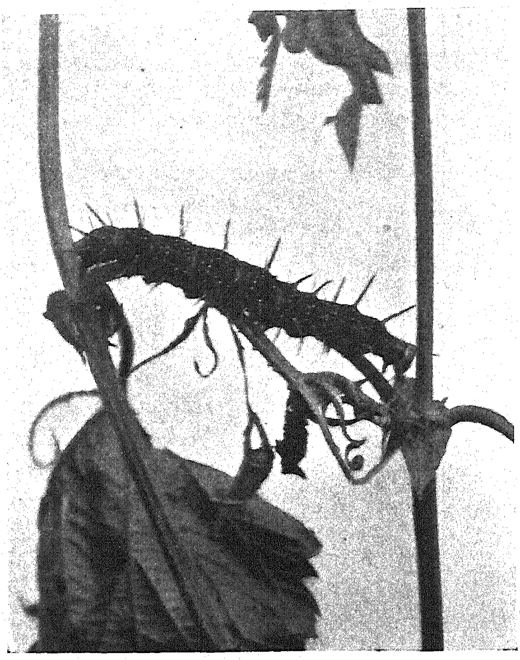

Fig. 16.
LARVA OF *Vanessa io* ON HOPS.

Morris, in his "British Butterflies," describes the pupa as of "a greenish colour, and dotted with gold."

Should it occur in any numbers in hop gardens, it could best be dealt with as at Goudhurst, by handpicking.

The Strig Maggot (*Diplosis humuli*) in Hops.

At Kingsnorth, near Ashford, Kent, many hops were noticed to be going off in early September. On the 24th samples were sent and typical Strig Maggot damage was detected.

The only method so far known of keeping the pest down, is folding sheep in the garden in autumn.

Hops attacked by *Blanjulus guttulatus* Bosc.

Writing from Staplehurst, a correspondent stated that many of his hops planted a few years back, on some old meadow land, were very weakly, and that he found the insects sent in numbers on the roots.

The animals were nearly all the small snake millepede (*Blanjulus guttulatus*), but also a few specimens of *Geophilus longicornis*.

Treatment by trapping as for a wire worm or the use of vaporite hoed in round the hills was advocated.

A Beneficial Mite (*Anystis cornigera* Koch) on Hops.

A correspondent at Etchingham, in Sussex, noticing that his hops were not looking healthy examined them and found only small mites upon them, which he thought were the cause of damage.

The specimens were sent me in June and were kindly identified for me by Mr. Cecil Warburton, as the *Anystis* (*Actineda*) *cornigera* of Koch, one of the Erythraeidæ, a family of *Trombidiadea*, thus coming near the injurious Red Spiders.

This mite, however, could not have been the cause of the stunting of the growth for it is to some extent useful, for it feeds upon Aphides and other small insects.

It may commonly be seen running rapidly over the leaves of garden plants and bushes, especially currants, where it undoubtedly feeds upon the Aphides *Myzus ribis* and *Rhopalosiphum lactucae*, but never in sufficient numbers to make its effect felt to any serviceable extent.

Eelworm (*Heterodera schachtii*) on Hops.

A large number of communications were received on this subject from Herefordshire, Worcestershire, Kent and Hampshire and one from Surrey.

This hop enemy seems steadily to be increasing, and undoubtedly is one cause of true Nettle Head in hops, but what is often called Nettle Head is certainly due to other causes.

Mr. J. Leeke, of Leigh, Worcester, and others, are experimenting with di-sulphide of carbon as suggested on account of certain hills treated at Wye, in 1908, showing a marked improvement and growing away from the disease.

The subject of this hop pest has been handed over to Mr Adrian Duffield for investigation.

ANIMALS INJURIOUS TO CEREALS.

The Frit Fly (*Oscinis frit* Linnæus).

Although prevalent all over Britain, this oat pest was not nearly so harmful as in the previous year.

Two bad cases were reported, one at Upton-on-Severn, Worcestershire, where a five-acre field was attacked, but only one acre to any serious extent. The land had been previously cropped with sweet peas, which had failed owing to the drought.

The other was at Cranleigh, Mr. Welch writing that the same fields that were attacked by Gout Fly in the previous year, were badly damaged this. Nothing but Frit Fly could be found in the oats sent. The stubble, etc., had been burnt in the previous year.

It was also again reported from Romney Marsh and also from several localities in Yorkshire, Norfolk, Suffolk, Northamptonshire and Essex.

Tulip Root in Oats.

The Tulip Root disease in oats caused by the Eelworm (*Tylenchus devastatrix* Kühn) was worse than ever in 1912.

Seventy cases were reported upon or examined during the year, in some instances the disease causing a total loss of crop.

One large grower near Peterborough, wrote that "it was now difficult to get a crop of oats on his fen land or high land, several thousand acres, where the seed has germinated but either died off or remained quite useless and stationary. The seed came from Scotland and near York and as far as could be seen, there was no difference. Formerly we could rely on a good crop of oats, but the last few years it is useless to grow them."

Mr. F. Smith, of Loddington, has informed me that he had given up growing oats in consequence of this disease. Another grower at Biddenden, wrote in June, that his oats were failing, nothing but Eelworm occurred in them. The oats were drilled late, but came up well ; they had five hundredweight of bone and meat meal when drilled and two hundredweight of nitrate of soda later. The Tulip Root had been bad the last two or three years. Another farmer at Witley, Surrey, reported similar damage in June, accompanied by Frit Fly.

Besides numerous places in Kent, it was inquired after from Norfolk, Suffolk, Huntingdonshire, Sussex, Hampshire, Northamptonshire, Essex, Devonshire and Lincolnshire.

Unless some natural check soon comes, and the disease ceases to exist in this epidemic form, the oat crop will be seriously jeopardised.

We know that by growing winter oats the disease can be combated, but it is only in certain cases that this can be done, so that it is little use recommending this. Still, a good many crops may be much improved by top dressings of artificials as soon as any signs of injury are noticed. A good dressing of a stimulating manure will often hurry a crop past its worst period if taken in time. Deep cultivation will also do some good, but as far as we know at present, if land gets eelworm sick, no matter whether it is with *Tylenchus* or *Heterodera,* that the only way to clean it is to let it be idle for two or three years or grow on it mangolds or barley or carrots that are not attacked during that time. Failing these we must give up oat growing on infested land.

ANIMALS INJURIOUS TO PULSE.

The Pea Leaf Miner (*Phytomyza pisi* Kaltenbach).

Peas, both culinary and ornamental were badly attacked in places in 1912, by the larvæ of the fly *Phytomyza pisi*,

Fig. 17.
THE PEA LEAF MINER (*Phytomyza pisi* Kalt.).

(Fig 17) and also by the larvæ of a smaller species which I have been unable to get identified.

A correspondent writing from Churt, near Farnham, in Surrey, on June 20th, said that "within the last few days

a bad disease has appeared on both my sweet and eating peas which have hitherto appeared perfectly healthy and doing well. It seems to affect the lower part of the plants most, in

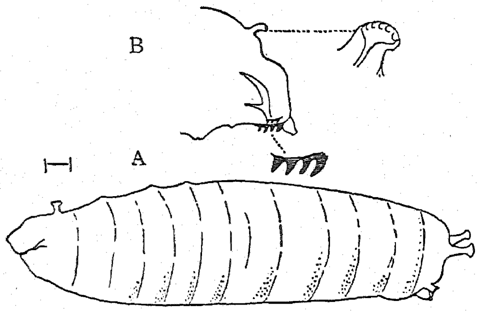

Fig. 18.
Larva of A the Pea Leaf Miner (*Phytomyza pisi* Kalt. (enlarged) ; B. further enlarged head.

some cases only the lower parts; both leaves and stems are attacked. It has also appeared in another garden near."

It has been found in garden cultivation that spraying with tobacco-soap wash three or four times at intervals of ten days, will keep this disease down.

Although it occurs in field peas, it seems to do but little harm.

It is advisable in gardens to burn the pea haulm as soon as the crop is picked to prevent many of the flies from hatching, for nearly all appear to pupate in the mines on the leaves and stems.

The Pea and Bean Weevils (*Sitones lineata* Linn., etc.)

A case of great damage to beans by the well-known Pea Leaf Weevils (*Sitones lineata*, etc.) was reported in May, by Mr. C. Love, of Eastchurch, Sheerness, who wrote that " they were destroying ten acres of beans, put in in January. The insects he said, were feeding ravenously on the leaves of the beans which were then in flower.

At such a time it is too late to do anything. This weevil commences its attack on the young leaves as soon as they are up, and it is at this time that they are usually most destructive.

In the field they may be checked materially by rolling with a light wooden roller followed by a good dressing of soot.

In the garden they may be combated by spreading fine soil along the rows followed by a dressing of soot and lime. In the bird crops investigation, carried on by Mr. McGowan it has been found that starlings devour great numbers of this and other allied *Sitones*, notably the harmful Clover Weevil (*Sitones flavescens*).

Eelworm (*Heterodera schachtii*) on Peas.

This "Eelworm" usually attacks sugar beet, hops, and wheat. In June, Mr. Emptage sent me samples of field peas which had great numbers of this parasite affecting them. The attack was similar to that on wheat that I have seen and on hops. Most of the females were packed with ova and in one case the whole root system was a mass of these parasites.

Stem Eelworm (*Tylenchus devastatrix*) in Peas.

An attack of the Stem Eelworm (*Tylenchus devastatrix* Kühn) on peas was reported from Send, Woking, Surrey, on June 27th. Both culinary and sweet peas were attacked and died off from the ravages of this pest.

The field peas had been grown three years running on the same land, with mustard and rape between each crop which was fed off by sheep. In an adjoining field, which was cropped with potatoes, last year, the peas were perfectly healthy, green and very vigorous.

The attacked plants sent showed brown and in some cases a black discoloration of the stems from the ground upwards; many were quite decayed.

Not only in the dead tissue, but also in the green tissue just above, countless *Tylenchus* were found and many ova and young; one specimen was literally packed with the nematodes.

Some of these were transferred to soil in which young peas had germinated, the soil being just as dug from the garden; two other pots had a good dressing of fresh slaked lime mixed with the earth, and one was dressed

with carbolic soap emulsion, the same as used for onion fly (p. 184). By the time the peas were eight inches high in the untreated pots, they were all badly infested, and some dying. Those in which the lime was mixed with the soil, were but slightly affected, and those in which the soil had been watered with carbolic emulsion showed no sign of the disease in the peas, but one or two eelworms were found in the stems.

ANIMALS INJURIOUS TO ROOT CROPS.

Cut Worms.

The larvæ of the Heart and Dart Moth (*Agrotis exclamationis*) and of the Yellow Under Wing (*Triphaena pronuba*) were very prevalent in the summer and autumn of 1912. Writing from Walmer on the 26th of August one correspondent stated that his fields were badly attacked by the enclosed grub. They had been so abundant that one field which had been cropped twice with mangolds had failed both times and they were appearing again in vast numbers.

These proved to be young *exclamationis* larvæ, some much more advanced than one would expect to find them at this time of year.

Land may easily be cleaned of these larvæ with vaporite, and when they are attacking a crop great numbers may be poisoned by the use of poison baits; that is bran or green stuff soaked in arsenate of lead. If bran is used, 1-lb. of arsenate should be mixed with the bran and made with water into a mash. If green stuff is used, it is as well to spray it heavily with arsenate of lead before being cut, and then put it about the fields in small heaps.

Ground Beetles Attacking Mangolds.

Every year notice is sent of the damage caused by Ground Beetles or Carabidæ to Mangolds.

A bad attack of *Steropus madidus* took place on the mangolds at Manor Farm, Witley, Surrey, in June, where Cutworms and the Pigmy Mangold Beetle were also working.

Steropus madidus was also observed by Mr. Dowling, attacking sugar beet, typical specimens of damage were sent.

The Pigmy Mangold Beetle (*Atomaria linearis* Stephens).

This pest of the mangold which is reported annually now, was sent from Manor Farm, Witley, in Surrey on 26th of June. The beetles appeared to have caused a considerable amount of loss and were working in conjunction with some other insect pests including cut worms.

Wire Worms.

Great damage from the Wire Worm appears to have taken place near Rochester. The Parish Council of Frindsbury Extra, Rochester, wrote asking for full information concerning the methods of checking the ravages of this pest, which had done great damage in the allotments of that parish, in August.

Mangolds in Berkshire were also found to be badly eaten.

The Swede Midge (*Contarinia nasturtii* Kieffer).

The attack on Swedes in Ireland referred to in my report for 1910, p. 90, has been traced by Mr. Taylor to the Midge known as *Contarinia nasturtii* Kieffer. An account of its life history has been given by Taylor in a paper on "Cabbage Tops in Swedes, Leeds, 1912," which I have not seen, and one also admirably figured by Carpenter in his Annual Report in the Economic Proceedings of the Royal Dublin Society, II. pp. 53-57, 1912.

Schoyen undoubtedly refers to this insect attack in Norway and calls it *Contarinia torquens*, (vide Beretning om Skadeinsekter oz plant oxygdommer i land og havebruket, 1909. p. 12, 1910). I found similar larvæ producing a like abnormal appearance here and there in swedes on Romney Marsh in 1912. So that this insect appears to be more general than was at first supposed.

Schoyen's record undoubtedly refers to the same insect, but which name is technically correct I am unable to say.

ANIMALS INJURIOUS TO VEGETABLES.

Baris Weevils (*Baris laticollis* Marsh) attacking Cabbages.

On June 10th, 1912, a communication concerning the destruction of cabbages in Cornwall, accompanied by specimens of larvæ and damaged plants was received, and a similar attack two days later from near Exeter in Devonshire.

The method and nature of working of the larvæ at once showed the pest to be a species of *Baris*, a genus of Rhynchophora or Weevils, widely distributed over the world, and of which no less than forty odd species occur in Europe and six in Britain.

The species which hatched out later proved to be *Baris laticollis* of Marsh.

Two species in Britain are known to feed upon Cruciferæ, namely, *B. laticollis* Marsh (usually known as *B. picina* Germ.) and *B. chlorizans* Germ. which is extremely rare and recorded only from Devizes. The latter feeds on Cruciferæ belonging to the genus Brassica and its close allies, the larvæ having been observed in the lower part of the stems of *Brassica oleracea* according to Canon Fowler ("Brit. Col. Vol." V., p. 381).

The larvæ of this genus all undergo their transformations in the stems or at the head of the root of their food plants, but *B. chloris* according to Plieniger (Ins. p. 525, 1837) forms galls on the roots and pupates in the soil, and the same habit was noticed for *laticollis* by Moncreaff (Fowler, v. p. 380).

The species sent from Cornwall and Devon are evidently the same as that recorded by Ormerod (Sixteenth Report, p. 23, 1893) under the name of Cabbage Stem Weevil (? *Bardius* sp.) with Taschenberg's figure of the beetle and larvæ of *B. chloris* and Bos' figure of the pupa of *B. laticollis* (*picinus*).

Ormerod's specimens came from Wells, Gorey, Co. Wexford, Ireland, where the maggots were doing much harm in the district, and she also refers to it as possibly occurring in Essex.

Taschenberg (Insekten-Kunde II., pp. 168-172) refers to four species, and to the damage caused on the continent to rape and turnips by *B. chloris,* and to cabbage and cauliflowers by *B. picinus.* The former does not occur in this country. The method of working is for the beetle to lay its eggs in the stems near the ground and according to Taschenberg also in the axils of the leaves.

In the specimens sent me the larvæ had completely tunnelled up the stem from just about ground level and some had eaten down into the roots for some distance. The tunnels were filled with *débris* and some of them were quite black. A few were empty and had a round hole in the side below ground level, evidently caused by the larvæ leaving the young dying plant, possibly to penetrate into another, for they pupated in the tunnels they had formed.

The maggots were white to dirty white in colour, with pale brown head, in some inclining to dull yellow, of typical weevil form, but not so much curved as is the case with most of them. They matured by July 15th, when they attained the length of one fourth of an inch, and pupated on the 16th. Pupation took place inside the tunnels they had excavated, and two adults hatched out on August the 5th, making the pupal life to be twenty days. Taschenberg gives the pupal life as about a fortnight.

The beetles appeared above ground and lived throughout the winter.

With *B. chloris* Taschenberg says that the "beetles appear customarily to remain in their shelter; still not unfrequently they appear and hide themselves for the winter."

It appears also probable that some may oviposit in the autumn and the larvæ live through the winter. Some very similar larvæ I found in Romney Marsh in 1911, in cabbage in January, may possibly have been this species wintering in that manner.

The beetle is about one-sixth of an inch long, black, shiny, with a thick punctured rostrum, the thorax finely punctate with a central smooth line and the wing cases with faintly punctured striæ.

The beetles under observation were extremely sluggish.

Canon Fowler records this insect at the roots of *Sisymbrium*

officinale and that the larvæ have been observed in the stems of cultivated cabbages and gives the following localities :—London District, rare, Battersea and Southend ; Charlton ; Suffolk ; Deal ; Folkestone (common) ; Rye ; Shirley Warren, Southampton ; Ventnor, Isle of Wight ; Portsmouth (abundant) ; Portland ; Southsea (in galled roots of *S. officinale*) as many as fifty from one root in July and August. The species appear to be confined entirely to the southern and south eastern counties.

Prevention.

All that can be done is to carefully pull and *burn* all infested plants.

Snow Flies (*Aleyrodes brassicæ* Linn.).

The prevalence of this pest in the West of England is now well known especially in Devonshire and Dorsetshire.

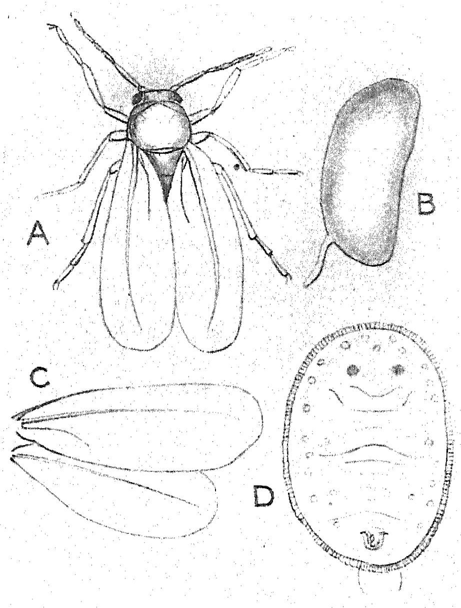

Fig. 19.

A. Adult Snow Fly. B. Egg.
C. Wings of Adult. D. Immature Snow Fly under Scale.

On May 14th, information concerning it was sought from Calstock, Cornwall. It seems to be widely distributed over Devon, Cornwall and Dorsetshire, where brassicous plants of all kinds are attacked by it.

Information concerning *Aleyrodes brassicæ* and its treatment was given in the last Report.

The Potato Aphis (*Rhopalosiphum solani* Theobald).

It appears that several plant lice attack the potato. A very bad case of tubers being attacked just as they were sprouting was reported from Folkestone by Mr. F. W. Betts in February. The tubers sent, a large box full, had every sprout smothered with "dolphin" which were excreting a great quantity of "honey dew." This honey dew had coated many of the tubers, and in consequence they had shrivelled up and in all cases the sprouts soon died. Practically, none of the seed was of any use for planting. The damage was caused by a *Rhopalosiphum*.

I found this aphis on potato-haulm at Wye in June and July, 1911, but only a few apterous females and a single winged female on June 28th.

On comparing the wingless females with those I found on the potato-haulm in June and July of last year, I found them to be identical, and they agree exactly with Kaltenbach's description of *Aphis solani* (Mono. Pflanzenlause, p. 15). This is placed as a synonym of Schrank's *dianthi* by Buckton. I recorded this, in the *Entomologist* as Kaltenbach's species, now I find a true *Macrosiphum* on potatoes that agrees more closely to Kaltenbach's insect, hence this is a new species. The long clavate cornicles separate it from *M. solani*, in which they are cylindrical. No damage has been reported as caused by this aphis to my knowledge, but John Curtis, in his famous work on Farm Insects, refers to aphis on potatoes (pp. 68 and 428), and calls them *Aphis rapæ*, or *vastator*.* Writing on the aphis in connection with potatoes, he says: "That aphides will puncture the potato-leaves there can be no doubt, and so incline them to wither, but there is no proof of them poisoning the plant and

* *Aphis vastator*, Smee, is considered by Schouteden to be *Rhopalosiphum dianthi*, Schrank.

so causing the rot . . . but in no instance have I seen aphides on potatoes in sufficient numbers to destroy the crop, or even to injure the produce." He then lists the aphides he had found on the potato, namely, *Aphis rapæ* Curtis; *A. humuli* Curtis; *A. persicæ*, Morren; *A. fabæ* Morren; and *Schizoneura lanigera* Haussman; and refers to the last as being only an accidental visitor.

The specimens I received from Folkestone were nearly all apterous females; on February 25th, I found a few nymphs, and on March 1st winged females commenced to appear.

They continued breeding on potatoes, alate forms occurring irregularly, until the end of May.

It may also be pointed out that in each of the six colonies sent me there were some pink forms mixed with the green and yellowish green normal specimens. The winged females that have come from the pink forms are identical with those from the green ones.

I found that this aphis lives quite well underground, and the alate females emerged from the soil in which I had placed one of the diseased tubers. It thus looks as if this aphis lays its ova on the tubers in the autumn, and there they remain until they sprout, and so are ready to work on the young shoots. A few years ago I remember finding a few aphis eggs on some potatoes, and probably they were of this species.

I have no other records of it outside Kent. Walker in his List (p. 990) also refers to it with a query as a synonym of *dianthi*, Schrank. It clearly comes in the genus *Rhopalosiphum*, the cornicles being most marked in the alate and apterous females, but not in the larvæ and nymphs.

Alate female, first generation.—Head black; antennæ brown, basal segment black, the second also rather dark, the third a little longer than the fourth, the fourth a little longer than the fifth, the sixth nearly as long as the fourth and fifth, the third with eight to ten sensoria on one side along nearly the whole length of the segment, the remainder of segments are striated.

Thorax: collar yellow, disc black in the centre, yellowish around and on the sides, which have also black areas. The black area not markedly trilobed as in *R. dianthi*.

Abdomen deep yellowish green with black transverse bars,

thin and indistinct on the first two segments, which have submedian black spots, the bars thick in the middle four segments, usually uniting into a dark mass, and there are also large prominent lateral black spots ; a dark area running from base of cornicles to the cauda.

The cornicles dark and slightly swelling towards their apices, cauda dark, acuminate, with three pairs of lateral hairs, surface and edges spiny. Legs yellowish, femora black on the apical half, apex of tibiæ and tarsi black, the paired ungues rather long. Wings normal, with brown stigma. Venter yellowish green to green, mesosternum black. Some specimens have the ground colour almost all yellow. The proboscis appears to be banded with narrow, dusky, and pale areas. The abdomen much darker than in *dianthi*.

Apterous female.—Variable in colour; bright apple-green dull green, and pinkish, shiny. Three forms occur, as follows:—

α. Pale green to yellowish green ; antennæ pale green, dark on the apical halves ; cornicles green, with small dark apical areas. Legs green, apex of tibiæ and tarsi dark. Eyes reddish black ; cauda green, tips of the cornicles nearly level with its end.

β. Bright apple-green ; head dark ; eyes reddish brown ; two basal segments of antennæ dark, the third pale at the base, remainder dark ; cornicles dusky, projecting a little beyond the tip of the dark caudal process. Legs dusky green, darker at the apices. Proboscis pale green, dark at the apex, reaching just past the base of the second pair of legs.

γ. Pale pink, with occasional ochreous areas.

In all the cornicles have marked transverse lines, and the third segment of the antennæ is longer than the fourth, the fourth slightly longer than the fifth, the sixth about equal to the fourth and fifth. Caudal process much as in the alate female.

Nymph.—All pale yellowish green or pinkish to yellowish brown. In some the head is pinkish, the thorax dull yellowish and the abdomen pinkish. Wing-buds dusky at the apices and sides. Legs pale, dusky at their apices ; antennæ pale, dark on the apical half ; cornicles pale, dark at their tips.

The sensoria on the third antennal segment of the alate female nearly agree with *dianthi,* but the general appearance of the insects differ, and also the thoracic and abdominal markings. Moreover, I could not get it to breed on peach or nectarine.

The Carrot Fly (*Psila rosae* Fabricius).

This well known pest was enquired after and methods of dealing with it asked for by Mr. H. Harborn, of Sellindge, Kent, in July. Writing on the 9th of that month, he said "large patches in the middle of the bed of carrots had completely disappeared and others are appearing at the margins."

An enquiry concerning the Carrot Fly was also received in May, from Hawick, N.B., where it was causing a good deal of loss.

The Asparagus Beetle (*Crioceris asparagi* Linnæus).

A bad attack of this well-known asparagus pest was investigated at Coleman's Hatch, in Ashdown Forest, Sussex, at Sir Edward Hope's in July.

The seed heads had been completely killed by the hosts of larvæ and beetles. They appeared to be breeding with great rapidity and were being collected in large tins full, without apparently making much difference as they kept hatching out. The shoots were also smothered with larvæ and ova at the same time.

This beetle was also complained about at Bournemouth.

Spraying with arsenate of lead is the best treatment at this time of the year, and will kill the larvæ off very rapidly, but it does not seem to affect the beetles to the same extent.

The Onion Fly (*Phorbia ceparum* Meigen).

This pest was sent from Hawick, N.B., in May, with a note that it was very troublesome there, and also from several places in Surrey.

There are several ways of combating this pest. It is important, if we can, to prevent egg-laying. This may to some extent be done by dusting the plant as soon as it is up with fine dry lime. After the eggs have been laid, I have found two methods do much good, one is to sprinkle ordinary crushed washing soda along the sides of the rows, and the other,

which undoubtedly worked the better of the two, was watering with carbolic emulsion. This emulsion was made according to Professor Forbes' receipt as follows :—ordinary hard soap one pound, soft water one gallon, crude carbolic acid, one pint.

The soap is dissolved in the water after being finely cut up, and then the crude carbolic is churned into the soap and water so as to make an emulsion. One part of this stock solution was diluted with thirty parts of water and the rows well soaked with it by means of a can with a fine rose.

Tomatoes attacked by *Collembola.*

The Springtails seem every year to become more widespread in their attack on plants. In June, some tomato plants were sent by Mr. James Mason, from Worcester, which were failing. The fine roots and rootlets were eaten or rather gnawed in many small patches and in some, these patches had coalesced until the greater part was damaged. The cause was traced to white Springtails. The species were mainly *Lipura ambulans.*

Spiders attacking Cucumber Blossoms.

On July 18th, Messrs. S. Bide & Sons, of Farnham, sent some spiders with a request for a remedy, saying that they were an awful nuisance in their cucumber houses used for seed production. "They eat the male blossoms every night and we have the greatest difficulty in finding sufficient to fertilize with. We have tried several things to destroy them, also to make the blossoms unpalatable to them by spraying with quassia; we have also used Clift's Fluid and found it very effective, but the difficulty is to wet them with it, as they retire behind the pipes and get under the bed. Last season we practically lost a seed crop owing to them."

On expressing some doubt as to the spider being the cause of injury, I received the following reply :—" I have actually seen them feeding on the cucumber blossoms myself, and I am sending you some, so that you may see the way they are attacked. They appear to go for the nectar at the base of the blossoms of the male flowers, which are sought after most, then the female. They are a very great trouble to us as we cannot get enough male blossoms to fertilize with."

Some live spiders were sent me, and I placed these in a mouse jar with a spray of cucumber in blossom. During the night, the two spiders had destroyed five blossoms and damaged two others.

They were watched tearing holes with their pedipalpi at the base of the blossoms, with the evident intention of taking the liquid collected there, and remained with their heads in the cavity about half-an-hour in one instance.

The "White Insects" of Guernsey.

Considerable damage is done in the glass-houses in Guernsey to tomatoes, etc., by what are locally called "White Insects."

In June, Mr. A. C. Bescoby, the States Chemist, who is paying special attention to the insect pests of that island, sent me specimens of these insects. They all proved in this consignment to be a species of *Scolopendrella*, one of the Myriapoda belonging to the order Symphyla. These Myriapoda seem to connect the Campodea with the true Myriapoda, but have legs on all the segments and different caudal processes.

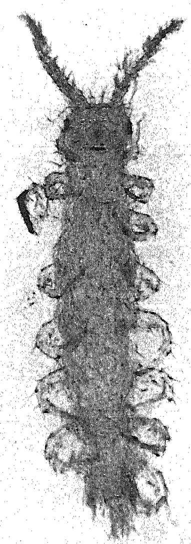

Fig. 20.
Scolopendrella sp., greatly enlarged.

Previously, a sample of infested soil sent on May 30th, contained nothing but *Enchytraeidæ*. These annelida are undoubtedly harmful, being partial parasites on almost all delicate plant roots, and no doubt were one of the causes of damage, which appears to be very serious in the early part of the year, and to persist in the glass houses all the year round.

But also amongst this soil, and in some other sent me, I found numbers of dead and a few living Collembola, *Lipura ambulans*, which were evidently the culprits.

What part the little white Scolopendrella were playing I could not make out.

FLOWER PESTS.

The Rose Sawfly (*Blennocampa pusilla* Klug).

Roses at Pirbright, Surrey, were badly attacked by the Leaf Curling Sawfly (*Blennocampa pusilla*) which were reported by Mr. W. H. Hooper on the 10th of July.

Eelworm (*Tylenchus devastatrix*) in Tulips.

A number of tulip bulbs were received from Dublin for examination. They were found to be badly infested with the Eelworm (*Tylenchus devastatrix*) and some also with Sclerotia.

As only Eelworm were found in many of the bulbs, there is no doubt that they are alone one of the causes of decay.

FOREST TREE PESTS.

The Pine Beetle (*Hylurgus piniperda* Linnæus).

Information concerning this Pine Beetle was sought by Sir Daniel Morris, K.C.M.G., of Boscombe, in December. In his communication he stated that it was doing a deal of harm among the pines at Bournemouth, and along that coast. Later, he sent a box of specimens of damage in which great numbers of beetles were found. As many as six were found hibernating in a single shoot. I visited Bournemouth in April, and found many trees badly attacked, and the beetle widely distributed. The pines here also had a great deal of the white aphis *Pineus pini* upon them, and some young trees were much stunted by it.

The life cycle of the Pine Beetle is well known. The winter is passed normally as adults which hibernate in rough bark, or they may eat their way just into healthy trees. These winter burrows are said to be quite harmless to the trees. It may be noticed that those sent me had hibernated in the hollowed and fallen shoots, and in that district, that appeared to be the main hibernating habit.

They become active again in April, in warm seasons even towards the end of March. They then commence to breed and are usually supposed to lay their eggs in sickly standing trees, or in trees felled during the previous winter. The female scoops out a round chamber, and here is fertilized by the male. The female then forms a gallery from two to three inches long with two or three air holes to the exterior. (Fig. 21 *a* and *b*). Here, in about fifteen days, larvæ are found which eat out at right angles to the mother gallery, forming at first small tunnels which gradually increase in size and at the end of these they pupate. These galleries are in the bark. When mature, the

beetles escape by eating their way out of the bark, leaving behind a number of so-called "flight holes." These beetles occur at the end of June and in July, and lay their eggs in the bark of felled trees. At the same time, the parent beetle has kept on laying and beetles hatch out from the parent galleries during the summer and autumn. Then the whole of them emerge about the same time, and bore into the pith of the young leading shoots and kill or damage them and they fall to the ground in autumn.

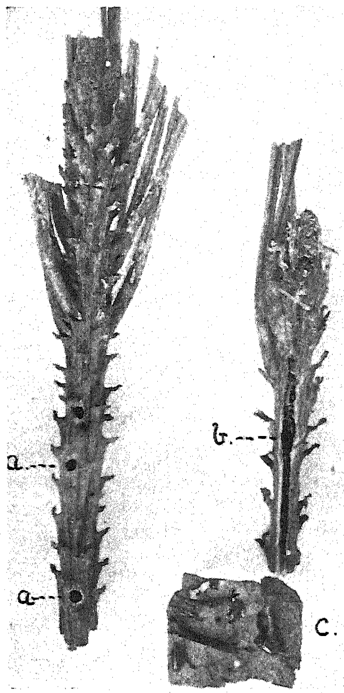

Fig. 21.
THE PINE BEETLE.
a. exit holes, b. tunnel.
c. beetles, half natural size.

Attacked trees have a curious stumpy appearance.

The beetles are about one-fifth of an inch long, with black head and thorax and pitchy coloured elytra; legs the same colour as the body, but the tibiæ are paler. The wing cases are slightly pubescent and have rows of fine punctures, the interspaces between the rows wrinkled, each containing a row of hairy tubercles. The grubs are white to creamy colour, with a yellow head; they vary in colour, some being yellow on parts of the body.

The prevention of this pest, which if left to go on increasing, may become very harmful, is mainly done by careful destruction of the breeding places, that is, in sickly standing trees or in fe led trees left lying about.

Trees should have the bark removed when felled if they cannot be cut up until the autumn, or when possible they should be cut in the autumn and cut up by March.

All the bark should be burnt, many larvæ and beetles being thus destroyed. Certain trees may be felled to act as trap trees, and then barked and the bark burnt.

In cases as at Bournemouth, where the trees are for ornamental and not forest purposes, and where the attack, or at least bad attack is localised, it would be worth while to rake up and burn the fallen tops in winter, for I found the beetles mainly hibernating there.

The Large Oak Borer (*Priodon coriacius* Linnæus).

Specimens of the larvæ of this beetle were received from Mr. Davidson, of the Cooper Research Laboratory, on the 15th of March. Although it is by no means a common insect, and is almost confined to the south of England; where it does occur, it now and then causes great damage to oak trees.

The beetle, which is fairly common in the New Forest, was also sent me from near Newport, Essex, and being in the neighbourhood, I found it working at Widdington.

The beetle seems to vary in size, some being only an inch long, some over an inch and a half. It is of a dark brown colour, somewhat shiny, thorax black with spines at the sides; in the male the thick antennæ are serrated.

The beetles are nocturnal and remain stationary on the trunks of the oak trees during the day time.

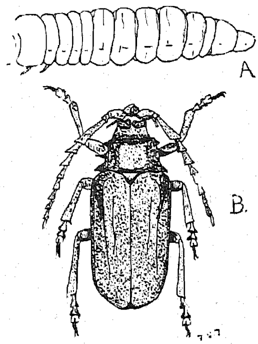

Fig. 22.
The Large Oak Borer
(*Priodon coriacius*).
A. Larva. B. Adult.
(two-thirds natural size).

The larvæ tunnel into the heart of the trees, and reach when full fed as much as three inches long. They are creamy white, flattish and broad, gradually narrowing posteriorly; the head can be retracted into the first thoracic segment, the first segment is short, the second large; there are three pairs of small legs on the three thoracic segments, the seven following segments having

fleshy tubercles. The brown mandibles are very powerful, but are small and triangular in form.

When full grown, they come near the surface and form a large cocoon of wood chips.

The Heather Beetle (*Lochmæa suturalis* Thoms).

Information concerning this beetle, was sought from Woburn. Some damaged heather was attributed to frost by the authorities at Kew, but as beetles were found attacking it, information concerning them was wanted.

There is no doubt that the Heather Beetle can do and often does a great deal of damage.

The Brindled Beauty Moth (*Biston hirtaria* Clerck).

A complaint concerning the damage caused by the caterpillars of the Brindled Beauty Moth (*Biston hirtaria*) was received in July, from Lady Forbes, who stated that the larvæ had eaten an enormous amount of foliage in her garden at Holland Park, London.

This moth appears in April. The male measures an inch and three quarters in wing expanse, the front wings are a greenish-grey to greenish-brown, somewhat speckled and with dark transverse wavy lines; the hind wings are paler, with three more or less prominent darker transverse lines; the wing fringe is composed of dark and light areas; the antennæ are plumose, but simple at the tip.

The female is very similar, but the markings are often wanting on the front wings and they are somewhat transparent; the hind wings are pale, with two lines across them and also somewhat transparent, and sometimes have a dull ochreous tinge. The caterpillar is very variable in colour, some are greenish, or greenish-brown, others almost brown, with a pale yellow interrupted line along the sides, yellowish spots on the sixth to tenth segments and greyish markings and pale stripes, and on the twelfth segment are two small prominences.

The larva feeds on a variety of trees, including elm, lime, hazel and privet. They are found from the end

of June into August, and when full fed they enter the soil to pupate.

It is a widely distributed insect, and may be found in most parts of England. Where the caterpillars are very abundant, as in the instance recorded here, they may easily be destroyed by spraying with arsenate of lead.

Willow Aphides.

The Aphides on Willows and Osiers appear to have been particularly prevalent during the summer of 1912.

The two most harmful species seem to have been *Aphis saliceti* Kalt. and *Siphocoryne capreæ* Fabricius.

Both these species were received from the Board of Agriculture in June from Bowdon, Cheshire and from Mawdesley, near Ormskirk, in August.

Siphoconyne capreæ was also sent by Mr. A. G. L. Rogers, of the Board of Agriculture from *Aegopodium podagraria* on June 7th. Another Willow Aphis sent by the Board from Selby, Yorkshire, attacking willows, was *Melanoxantherium salicis* Linnæus during May.

Siphocoryne capreæ and *Aphis saliceti* were also received from Lalkeld Dykes, near Penrith, Cumberland, from Mr. Britten ; from Godalming, Surrey, and Worcester.

Both were found in great abundance at Oxford, at Hastings, Bournemouth, Wye and near Maidstone.

Lachnus viminalis Fonscolomb was also received from Crewe, Cheshire, and from Bromley, Kent.

Fifteen species of Aphides are found on Salix in Europe, of which I have found nine in Britain.

The following are the species recorded from Salix :—

List of European Salix-feeding Aphides.

* 1. *Aphis saliceti* Kaltenbach.
Mono. d. Fam. d. Pflanzenlause, p. 103 (1843).

2. *Aphis salicariæ* Koch.
Die Pflanzenlause Aphiden, p. 144. figs. 195, 196, (1857).

3. *Aphis spectabilis* Ferrari.
Ann. Mus. Civ. Gen. II., p. 64 (1872).

* 4. *Aphis alterna* Walker.
The Zoologist, VII. p. xliii. (1849).

* 5. *Aphis secunda* Walker.
The Zoologist, VII. p. xliv. (1849).

* 6. *Siphocoryne capreæ* Fabricius.
Ent. Syst. Nat., IV. 221. 3.

* 7. *Siphocoryne pastinaceæ* Linnæus.
Syst. Nat. I., II. p. 734. 21. 3.

8. *Chaitophorus vitellinæ* Schrank.
Fauna Boica. II. 103. 21. 1178.

* 9. *Chaitophorus salicivorus* Passerini.
Gli Afidi. p. 58. 1860.

10. *Chaitophorus salicti* Schrank.
Fauna Boica. II. 103. n. 1177.

*11. *Chaitophorus capreæ* Koch.
Die Pflanzenlause Aphiden, p. 6. 1857.

12. *Chaitophorus hypogeus* Del Guercio.
Mem. Soc. Ent. Belg. XII., p. 213. 1906.

*13. *Melanoxantherium salicis* Linnæus.
Syst. Nat. 2. 736. 26.

14. *Melanoxantherium flocculosum* Weed.
Insect Life, III., p. 292. (1891).

*15. *Pterocomma pilosa* Buckton.
Mono. Brit. Aph. II., p. 143. p. lxxxiii.

*16. *Cladobius populeus* Kaltenbach.
Mono d. Gam. d. Pflanzenlause, p. 116. (1843).

*17. *Lachnus viminalis* Fonscolomb.
Ann. d. la. Soc. Ent. Fr. T. x. p. 184. (1841).

18. *Lachnus longirostris* Fabricius.
Ent. Syst. IV., p. 210. MDCCXCIV.

A New Willow Aphis (*Pterocomma bituberculata* nov. sp.).

Alate viviparous female.

Head and thorax dark brown; abdomen paler brown; thorax with darkened lobes; eyes black, much projecting laterally; head with rather long fine hairs in front; antennæ with the third segment and base of the fourth pale brown,

rest dark brown ; the third segment a little the longest, with a row of eight to nine sensoria and two separate ones near the apex, the fifth segment slightly longer than the fourth, the sixth not quite as long as the fifth, the fourth, fifth and sixth striate, the third with several long, fine hairs on one side, a few on the side of the sensoria, the fourth with a few and two or three

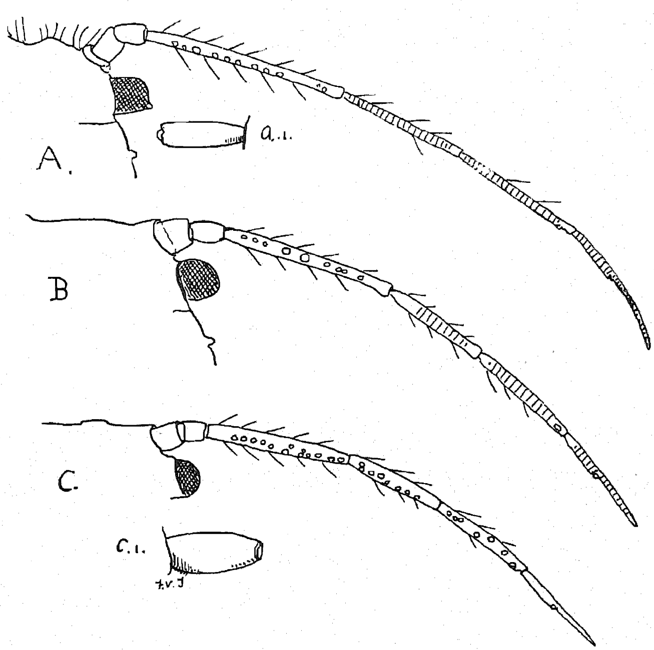

Fig. 23.
Pterocomma bituberculata nov. sp.
A. Alate viviparous female. B. Oviparous apterous female.
C. Apterous male.

on the fifth ; the pronotum with a small, prominent, rounded tubercle on each side. Cauda short and dark. Cornicles short, pallid, simple. Legs brown ; apex of tibiæ and the tarsi dark, femora and tibiæ with many fine rather long hairs. Wings large, longer than body, with brown stigma and veins. Length, 3 mm.

Oviparous female.

Apterous, elongated, oval, brown. Pronotum tuberculate as in the alate female. Eyes prominent but more rounded. Antennæ shorter than in alate form; the third segment with nine to ten sensoria, the fifth a little longer than the fourth, the sixth about as long as the fifth. Legs, cornicles, etc., as in the alate form. Length, 2.5 to 3.5 mm.

Male.

Smaller, brown, apterous; penis rather long and thick, tapering to a blunt point. Antennæ about two-thirds length of body; third, fourth and fifth segments with sensoria, most on the third (twelve to fifteen), eight on the fourth and seven on the fifth. Legs, etc., as in the female. Length, 1.5 to 2 mm.

Habitat.

Great Lalkeld, Penrith, Cumberland, feeding on Salix, 17.10.12.

Notes.

All three forms taken together by Mr. Britten, evidently in company with *Lachnus viminalis.*

The cornicles are marked but rather short.

It evidently comes with *Pterocoma,* but differs from *pilosa* in the less hairy nature and in the structure of the antennæ, as well as being much larger and without the banded abdomen. I can detect no sensoria on the oviparious female hind legs.

Aphis saliceti Kaltenbach.

The winged female is black, with dark green abdomen, rather long, thin, yellow cornicles, with or without brown apices. Genital process short and green. The third segment of the antennæ is rather thick and has many sensoria.

The abdomen has some dark brown transverse bars, and four black lateral spots.

The legs olive green; tarsi dark and apices of the tibiæ.

The apterous female is bright yellowish green all over; eyes dark brown; the yellow cornicles sometimes have dusky tips and the tarsi and apices of the tibiæ are dusky. There are a pair of lateral prothoracic tubercles.

In all stages there is a marked dark rounded process with two hairs over the cauda. (Fig. 24 *c*).

This species occurs in the leaves of *Salix capreæ, S. album, S. cinerea,* and *S. viminalis*. It clusters under and

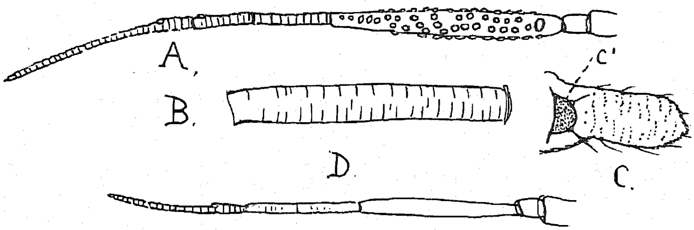

Fig. 24.
Aphis saliceti Kaltenbach.
A. Antenna of alate female. B. Cornicle. C. Cauda and process C' above. D. Antenna of apterous female..

upon the leaves and young tips of the shoots which I have frequently seen it kill.

The alate forms occur in July and by September all have flown. It is subject to much variation in colour.

Localities.

Fernhurst, Surrey (Buckton); Wye, Faversham, Maidstone, Penshurst, Folkestone, in Kent; Hastings and Winchelsea in Sussex; Bowdon, Cheshire; Mawdesley, near Ormskirk; Lalkeld Dykes, Penrith; Oxford; and Bournemouth (Theobald).

Probably widely spread over the country.

Ferrari records it on *Salicis viminalis*, Serraville Scrivia in Italy.

Aphis spectabilis Ferrari.

I have been unable to detect this species; described from Italy, so append Ferrari's original description and the differences from *saliceti*.

" Fem. apt. $1\frac{1}{2}$-$1\frac{3}{4}$ mm.

Oblongo elliptica, fuscoviridis, medio et lateribus fusciori variegata, hud pulverulenta, nec nitida. Antennæ dimidium corpus longitudine superant, articulo tertio vix duobus basilaribus conjunctis longiore, articulo 4, 5, 6, gradatim singulo praecedente breviaibus, septimo coeteris longiore.

Collum, abdominis *latera* et secundum segmentum anale utrinque mucronata. *Nectaria* et *cauda* viridi flava; illa bis triente hanc saperant et femora postica longitudine aequant. *Rostrum* pedum posticorum acetabula adtuigit.

Nectaria longa flavescentia aut pallidissima. Cauda fusco-viridis; latera et penultimum segmentum abdominis mutica———*saliceti* Kalt.

Cauda et nectaria flavescentia; latera et abdominis penultimum segmentum utrinque mucronata; rostrum ad acetabula pedum posticorum extensum———*spectabilis*.

Schouteden records this species from Blankenberg, Belgium (Aphid. Belg. p. 228), as *Salex* sp. and puts a query Kaltenbach's *Aphis amenticola*.

Aphis salicariæ Koch.

A rusty yellow species when alate with black head and thorax, black cornicles, four pairs of black lateral spots before the cornicles, one at their base and two below them; and three small black patches on the last three segments and a black cauda and black antennæ; red eyes and yellowish legs with dark tarsi. The apterous female is brown, with dark cornicles, yellow legs and antennæ, apices of the tibiæ and the tarsi black and the apices of the antennæ dark; both forms are pilose.

I have not yet found this species in Britain, but I once found it on Salix near Calais.

Aphis alterna Walker.

The alate female is described by Walker as follows:— "The body is small and black; the abdomen is rather dark green; the antennæ are almost filiform and much shorter than the body; the rostrum is a little paler towards the base; the tubes are dark green, with black tips and full one-fifth of the length of the body; the wings are colourless and very much longer than the body; the squamulæ are yellow; the stigmata and the veins are brown."

Found on *Salix caprea*. No date or locality given.

Aphis secunda Walker.

Alate viviparous female. "The body is black, shining and of moderate size; the antennæ are very much longer than the body; the rostrum is yellow, with a black tip; the tubes are as long as one-fourth of the body; the legs are yellow and rather long; the four hinder thighs, excepting the base, the tips of the fore thighs, the tarsi and the tips of the tibiæ are black; the wings are colourless and very much longer than the body; the wing-ribs and the rib-veins are yellow; the brands are pale brown; the veins are brown."

Found on *Salix caprea*. No date or locality.

Siphocoryne capreæ Fabricius.
Aphis capreæ Fabricius.
Aphis ægopodii Scopoli.
Aphis cicutæ Koch?

Ent. Syst. Nat. IV., 221. 3. Fabricius; Ent. Carn. 399. Scopoli; Die Pflanzenlause, p. 24, Koch.

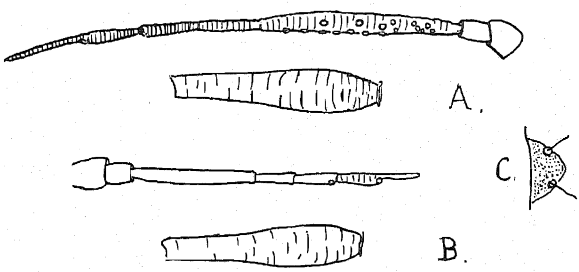

Fig. 25.
Siphocoryne capreæ Fabricius.
A. Antenna of alate female and Cornicle. B. of apterous female.
C. Process over tail.

This common Willow Aphis was placed in the genus Rhopalosiphum by Koch and I see no reason why the genus Siphocoryne should have been formed. More recently Schouteden and others have placed it in the genus Hyadaphis.

To save confusion I am adopting the most common generic name.

The alate female has a black head and a large black patch on the thorax, the rest yellowish green. The abdomen is pale

green to yellowish green with traces of dark bars in some, in others, as Koch figures, three spots on each segment. The cornicles are clavate and green, rather long and imbricated. The legs green to yellowish green, the tarsi and tibiæ brownish. The antennæ are dark, the third segment nearly as long as the last three, with eighteen or twenty-four sensoria, the fourth and fifth are nearly equal and the basal portion of the sixth as long as the fifth. The antennæ are much shorter than the body.

This very common species migrates between Salix and various *Umbelliferæ* and winters on Salix.

It is found on all kinds of Salix, and feeds on the leaves and young shoots. I have found it from early April to late August, only some few however seem to remain all the summer on Salix, the majority migrate to Umbelliferæ.

It often occurs in such numbers that the tips of osiers and willows are killed by it.

Whilst I have found it on most Umbelliferæ, it has occurred in most numbers on *Heracleum spondylium* and then on *Aegopodium podagrarium.* It has also been found on *Pastinaca sativa, Daucus carota, Erysimum vulgare* and once on *Populus.*

Schouteden and others consider that Koch *pastinaceæ* and *umbellatorum* are the same, they are quite distinct, the former occurs on both Salix and Umbelliferæ, the last only on Umbelliferæ as far as I know at present.

Schouteden especially mentions *capreæ* as occurring on *Salix babylonica* and *S. aurites* in Belgium.

Ferrari records it from Liguria under the leaves of *Liatris gummiferæ* in April.

Some notes from my diary re dates are 2. 5. 11 ; 3. 6. 11 ; 29. 6. 11 ; 12, 9, 11 ; 4, 10, 11 ; on Willow ; 3, 6, 11. ; 4. 7. 11. on *Heracleum.*

Siphocoryne pastinaceæ Koch.

This is a well marked species, but since Koch described it, it has been considered the same as *S. capreæ.*

It differs from the latter in having dark clavate cornicles, not pale green ones, a darker cauda and quite different antennæ in the alate female. The third segment of the

antennæ has between forty and fifty sensoria, and the basal area of the sixth is markedly short, whereas in *capreæ* it is long.

Like *capreæ*, there is a marked dark process over the cauda, with two hairs, exactly the same as occurs in the thin siphoned *Aphis saliceti*.

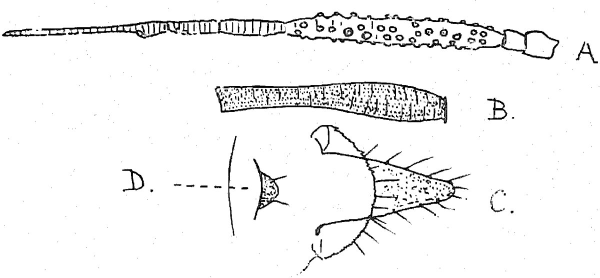

Fig. 26.
Siphocoryne pastinaceæ Koch.
A. Antenna of alate female. B. Cornicle. C. Cauda.
D. Process above tail.

It is probably this character, which is shown in the figure 25, and which also occurs in the common Willow Aphis (Fig. 24), that has made this confusion.

This species also inhabits both the genus Salix and many genera of the Umbelliferæ.

I have received it from Great Lalkeld, Cumberland; Worcester; Cambridge; New Forest; and have found it at Wye, Tonbridge, Exeter, Fowey, Plymouth, Torquay, Widdington and Esher.

Chaitophorus vitellinae Schrank.

This has not been yet found in Britain.

Chaitophorus salicivorus Passerini.

This is a common aphis where I have found it, but it seems to do no harm. The apterous female is green, very small and covered with fine, long hairs, with faint dusky spots in rows. Cornicles very small, green. Legs stout and short, yellow to yellowish green. Cauda small and blunt. Eyes large and brown.

I have never been able to find the winged viviparous female or any alate form.

It occurs from April to late September, and then the sexuparæ appear in October.

Ovigerous female.

Wingless; green with large red brown to black eyes; hairy, hairs long; cornicles short and yellow. Some semi-transparent. Antennæ shorter than the body, the fourth to sixth segments dusky. Legs yellowish green, tarsi dusky, slightly

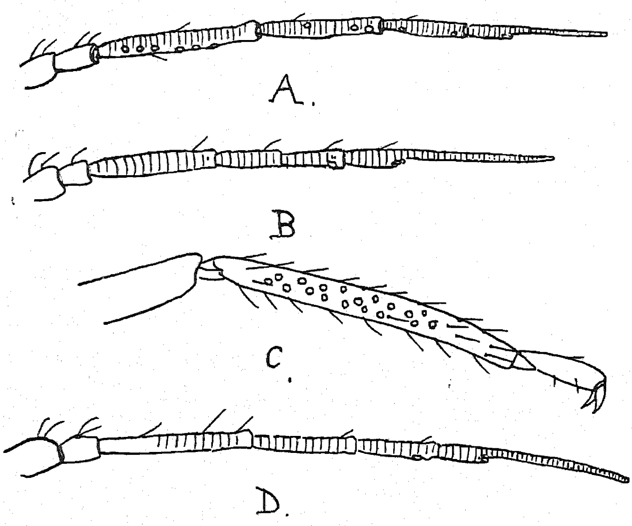

Fig. 27.

Chaitophorus salicivorus Passerini.

A. Male Antenna. B. Ovigerous female. C. Hind leg of oviparous female. D. Antenna of apterous viviparous female.

hairy. The hind tibiæ (Fig 27 *c*) with sensoria except at the base and apex.

Male.

Wingless; dusky greenish brown, head darker, large; eyes black; hairy, hairs arising from distinct tubercles, which appear as pale round spots in preserved specimens.

Antennæ brown, about the length of the body in some, shorter in others, and in one specimen I have longer than the body

The first two segments are about equal in length, the third is the longest and has six to eight irregular arranged sensoria, more or less in a line on one side; the fourth is more than half the length of the third, with two to three sensoria, the fifth is shorter than the fourth, and has two to four sensoria, the sixth a little longer than four and five together, all the segments striated; cauda dark, knob shaped. Length 1 mm. to 1.5 mm.

The sexuparæ occur in October.

Walker, who redescribed this species in the *Annals and Magazine of Natural History*, 2nd Sec. I., No. 6, p. 453 (1848), says, " Sometimes above eight hundred insects of this species feed together under a single leaf of the willow, *Salix capreæ*, from the beginning of May till the end of October, the last month being the time for the appearance of the male and of the oviparous female. Buckton records it from Critchmere, near Haslemere, I have found it at Wye, New Forest, Torquay, Fowey and Hastings, and have received if from Great Lalkeld, Cumberland, from Mr. Britten, in 1912. Schouteden records it from Belgium (Aphid. Belg. p. 213). It occurs on *Salix capreæ*, *S. cinerea* and *S. lapponum*, and does much harm to the foliage. I have always found it under the leaves and very sluggish in habits.

Chaitophorus salicti Schrank.

The winged female is black, the abdomen greenish, with brown bands; very short, thick brown cornicles.

Not recorded in Britain. Passerini (Gli Afidi, p. 60) records it from Italy, and Schouteden (Aphid. Belg. p. 213) from Belgium on *Salix cinerea*.

Ferrari records it from Liguria under the leaves of *Salicis albae* in June.

Chaitophorus capreæ Koch.

The apterous female is bright green to yellow, with dusky head and red eyes.

Abdomen with irregular dark markings, one of which is a forked dorsal stripe; the head is hairy in front, and the body has tufts of hairs springing from tubercles. The legs are green to yellow, tarsi dusky. Cornicles very small and black.

The winged female has a black head and thorax ; dull green abdomen with two darker lines and darkened at the sides. Legs yellow, tarsi dusky. Antennæ yellow, dusky at the tips. Wings with a dusky stigma. Abdomen, legs and antennæ hairy.

I have never been able to breed the alate female, lthough the apteræ I found once common on *Salix capreæ*.

Found on the leaves of *Salix capreæ*, and *S. nigricans* in July and August.

Localities.—Wimbledon, Wandsworth (Buckton), Wye (Theobald)

Schouteden records it from Belgium (Aphid. Belg. p. 213.)

Chaitophorus hypogeus Del Guercio.

Found in Italy on *Salix repens*. Not known in Britain.

Melanoxantherium salicis Linnæus.

A large, sooty black to dark grey species, with orange antennæ, legs and cornicles, the legs with dark apices to the femora, and tibiæ and dark tarsi. The abdomen has a pale median dorsal line and pale grey patches, two on each segment, variable in size and shape, the ones at the base of the cornicles

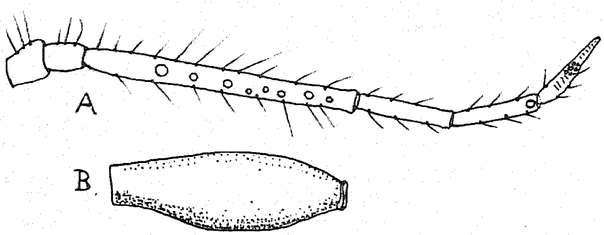

Fig. 28.
Melanoxantherium salicis Linn.
A. Apterous viviparous female Antenna and Cornicle B.

the largest. The winged female is greyish-black and hairy, legs and cornicles as in the apterous female ; the abdomen has two or more grey dorsal patches ; the wing veins are black and prominent. The cornicles are skittle shaped.

It occurs in dense masses on the shoots of osiers. I have also found it on *Salix capreæ* and *S. viminalis*. The individual colonies often number many thousands, one I found on an osier two feet long, completely covering the shoot. They kill the shoots and the attacked wood is stained, even when but few are present.

The apterous females were first noticed in April, and went on breeding until the end of June, when alate females appeared and left the willows.

I have records of it from Wye and Sittingbourne in Kent; Kingston-on-Thames and Putney in Surrey; Buckton records if from Shere, near Guildford, and specimens sent by the Board of Agriculture came from Selby, Yorkshire.

Walker (Anns. and Mag. Nat. Hist., 2nd Sec. I., No. 6, p. 452, 1848) describes this species, but the apterous female he describes is not *salicis*.

Melanoxantherium flocculosum Weed.

This American species has been recorded in Belgium (Boitsfort, Francorchamps, Frasnes) by Schouteden on *Salix cinerea* (Ann. Soc. Ent. Belg. XLIV., p. 128, 1900).

Pterocomma pilosa Buckton.

The apterous female is green spotted and marked with darker green and the whole insect covered with fine hairs. The antennæ are short and the legs stout and hairy. The green cornicles moderately long.

The alate female has a rusty brown head and thorax, the lobes of the latter dark brown; the abdomen is dull greenish grey to ashy grey, the segments with broad brown basal bands, not extending right across the body.

The cornicles are grey, cylindrical and moderately long. Legs brown to pale brown. Antennæ brown; wings long and pointed.

This species lives on the shoots and even thick branches, and also on the leaves in large colonies.

They may be found from April to November, winged females occur in May and also in August and leave the willows.

The ova were found and females still ovipositing in November. The eggs are oval and are laid on the twigs in

elongated gummy patches, of a dirty olive brown colour. Winged forms were sent me in May. The ova hatched in April. Both eggs and insects produce an intense deep red hue when put in alcohol.

It is recorded from Kentish Town (Buckton), Wye, Faversham, Eynesford, Canterbury, Pluckley, Paddock Wood, Kent; Cambridge (Theobald); Lalkeld Dykes, Penrith and

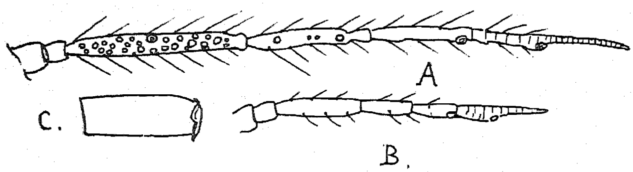

Fig. 29.
Pterocomma pilosa Buckton.
A. Alate female antenna. B. of apterous female.
C. Cornicle of apterous female.

Great Lalkeld, Penrith, Cumberland, June, 1912 (Britten), and Chandlers Ford, New Forest, April 22nd, 1912 (Duffield). It was very abundant in Kent in 1897.*

Specimens sent me from Eynesford in 1898 were doing considerable damage to the willows and also to a weeping willow in that neighbourhood. Schouteden records it from Belgium (Aphid. Belg. p. 214) on *Salix cinerea*.

Cladobius populeus Kaltenbach.

The apterous female is longish oval and varies in colour from dull yellowish grey to dull yellowish brown, grey or greenish grey, and is very hairy, the hairs arising from tubercles.

The head is brown, and the abdomen has a variable number of brown to black blotches over it. The antennæ are dull yellow, dark at the tips. Legs short and dull yellow and hairy, with black tarsi and tips to the tibiæ. Cornicles yellowish and short. The winged female I have not seen, Buckton describes it as " dirty greenish yellow, with brownish head, large red eyes, green antennæ, with brown tips, and

* Notes on Insect Pests for 1898. *Journ. S.E. Agri. Coll.*, No. 7, pp. 58-59. August, 1898. F. V. Theobald.

rather pilose. Thoracic lobes and scutellum dark brown. Abdomen arched and shiny, rather pilose, cornicles yellow and cylindrical, etc."

There is no doubt that the alate female described by Buckton is not this species at all.

Koch figures and describes this species, and his description answers to Kaltenbach's species.

The winged female is deep greyish brown, hairy, with black head, antennæ and thorax, the latter with pale reddish marks; the abdomen deep brown with yellowish bands to the segments, and yellow knob-shaped cornicles.

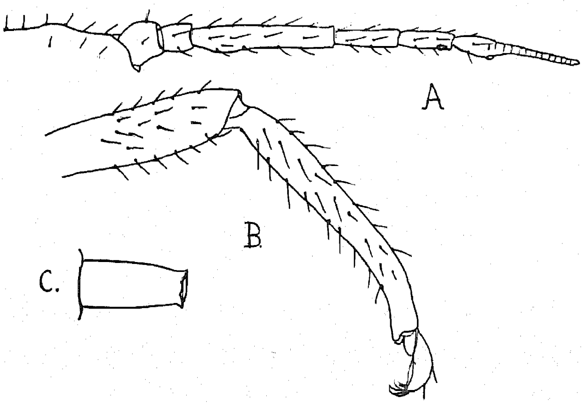

Fig. 30.
Cladobius populeus Kalt.
Apterous female.
A. Antenna. B. Hind tibia, etc C. Cornicle.

The legs are yellowish with black apices to the femora and tibiæ, very large on the mid and hind legs, and black tarsi.

This species occurs in dense, tightly packed colonies on Poplars and Willows. Walker (p. 451) says it sometimes occurs near London in the summer on the twigs of the Lombardy poplar (*Populus dilatata*) and of the Willow trees (*Salix alba, vitellina* and *caprea*), and is attended by large companies of ants (*Formica rufa*), and also that it is infested by an *Aphidius*, and is also devoured by the grubs of a *Syrphus* and of an *Agromyza*.

I have never found the alate forms, but have several

times found the apteræ in colonies, three to four inches long, on the wood of willows and poplars in Kent.

Their curious dull, hairy appearance is very marked, and also their somewhat bug-like resemblance.

It is doubtful if Buckton's description refers to this species. So I only give its record as from Wye and Kennington, Kent.

Ferrari records it on *Populi italicae majo*, in Italy.

Schouteden records this from Belgium (Aphid. Belg., p. 214), on *Populus nigra*, under the genus *Pteracomma*. It cannot come in the same genus as *Pilosa* Buckton.

Lachnus viminalis Fonscolomb.

A large species, the apterous female being 4 to 4.5 mm. long, globular, dark brown, some being paler than others and some having an ochreous tinge, shiny, and with fine grey

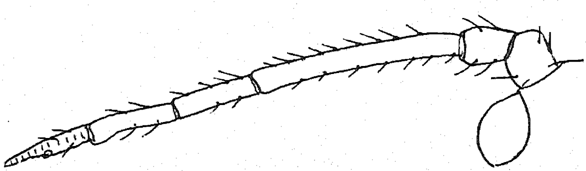

Fig. 31.
Lachnus viminalis Fonscolomb. Apterous female.

hairs. The abdomen has in the middle of the dorsum a horn-like process and several rows of transverse dark spots. Cornicles large and obtuse, dark brown. Antennæ short; legs long, especially the hind pair, and slightly hairy.

The alate female varies from 4.5 to 5 mm. long, with a wing expanse of 15 to 16 mm. The colour is the same as the apterous female, but the abdomen has no median horn, but a large black spot and rows of smaller black spots. The legs are dull reddish brown, with dusky tarsi and tips to the tibiæ.

This species occurs in dense colonies on the shoots and branches of all kinds of Salix, and often in such masses that the trees are killed by them. It especially occurs on *Salix viminalis*, *S. capreæ*, and *S. cinerea*.

The aphides are packed close together, nearly always with their heads downwards. They are very sedentary, but if they are touched, like all Lachnus, they throw their

long hind legs in the air and wave them about—if one or two only are made to do this by some stimulus the rest of the colony soon follow.

They secrete a vast quantity of honey dew from their ani, and this falls on the leaves below and covers them with a sticky mass that becomes covered with soot fungus, and the leaves soon die and fall off.

This honey dew attracts large numbers of wasps, which feed upon it, but bees and ants avoid it.

This Aphis appears in vast numbers in certain years, then the winged brood occurs and they fly off, where to is not known, and perhaps it may be five or six years before any are seen in the locality again.

The apteræ also migrate *en masse* sporadically; one may find them on one tree one day, and the next not a trace, but the same colony which I once marked with colour were found on another Salix twenty yards away. A similar occurrence is mentioned by Buckton (p. 57).

The effect of these aphides, even if in only very small colonies, is plainly marked on the wood.

The colonies are often a foot in length, and from one to three inches wide; in one group, some years ago, I counted up to seven hundred individuals.

As a rule, I have noticed many colonies on one tree. Each colony starts by a single winged female, which was observed to crawl from a neighbouring mass of aphides, and at once commenced to produce young. In all cases seen by me the insects were grouped together side by side with their heads pointing upwards, not as stated by Buckton, downwards (Mono. Brit. Aph., III., p. 55, 1880).

The general effects on Salix caused by this large Dolphin are varied. At one time they seem to do no harm, save by causing the leaves to fall from the effects of their excretions. At other times, or even at the same time, a neighbouring Willow will be killed by the aphides sucking away on the stems and branches. Young trees and osiers frequently die under a persistent attack.

Buchton records a case where this insect occurred in such numbers at Carshalton, that trees thirty and forty feet high were killed by them, and at the same time mentions that a

resident horticulturist at Nottingham stated that it did no harm at all.

Wherever the insects puncture the bark they make a reddish-brown stain, and as they often occur in rows more or less prominent brown streaks occur in the rind.

I have found this aphis from June until November, but its period of greatest abundance is in September and October, when winged females appear in numbers.

The alate females stay a short while in the colonies, and then crawl away or may fly off in swarms.

The winged females may settle with their heads pointing upwards or downwards. Twice I have found what are evidently their ova in winter, laid in great masses on the rind of the smaller branches and twigs.

This Lachnus when crushed gives a rich red stain, which dyes, I have found, cloth pink, and which does not fade.

Localities.—Carshalton and Nottinghamshire (Buckton), Enfield, Wye, Canterbury, Kingston-on-Thames (Theobald).

References.

Curtis: Linnæan Soc. Trans., Vol. 6.

Buckton: Mono. Brit. Aph., III., pp. 53-57, Pl. XCIX.

Fonscolomb: Ann. d. l. Soc. Ent. Fr. Tome 10, p. 184, 185, 1841.

Theobald: Rept. Eco. Zoology, *Jour. S.E. Agric. Coll.*, No. 14, pp. 126-132, Fig. 36. 1905.

Theobald: First Rept. Eco. Zoology (Brit. Mus.), p. 116, 1903.

Lachnus longirostris Fabricius.

This has as yet not been recorded in Britain. Fabricius describes this species as follows:—" Aphis cinereus rostro corpore triplo longiore. Habitat Dresdæ sub corticibus arborum. Formicarum larvis victitam. Medius rostrum longissimum, cylindricum, quo larvarum cuccum haurit."

Passerini (Gli. Afidi, p. 38) and (Aphid. Ital., p. 65, n. f.) refers to *Aphis* (*Lachnus*) *longirostris*. Ferrari (Aphid. Linguriæ, p. 81) refers to *Lachnus longirostris*. Fabr. ? and refer to Passerini's works, recording this insect from " Serravilla Scrivia, in rimis corticis *Salicis viminalis, S. albæ* et *Populi nigræ*. Septembri, Octobri."

It should at once be told by the long rostrum, similar to that seen in *Stomaphis quercus* Linnæus, the *longirostris*, of Boyer, not of Fabricius, and which occurs on Quercus in Britain (*vide* Buckton, III., pl. CI.).

Conifer Gall Aphides.

Three aphides on Conifers were received during the year with requests for information concerning them, namely *Adelges abietis* Linn., and *Cnaphalodes strobilobius* Kalt., which form galls on *Picea excelsa*, and which live on the needles and bark of *Larix europæus*.

Cnaphalodes strobilobius (Pl. XV. *a*) is more harmful than *Adelges abietis*. They were causing some inconvenience in a nursery at Hereford, and were sent with a request as to how best to destroy them in June. Specimens of these common galls were also received from Worksop, Widdington, and Henley. The other form sent was *Pineus pini* Linn. (Pl. XVI.), which occurs as a white woolly aphis on *Pinus*, between the needles, and on the wood, and as a gall former on *Picea excelsa* and *Picea orientalis*.

The galls are shown on *Picea excelsa*, and the Pinus form in separate photographs (Pl. XV. *b*).

Full information concerning these Conifer Aphides can be found in Dr. Carl Börner's work " Eine monographische Studie über die Chermiden." Arbeiten aus der Kaiserlichen Biologischen Anstalt für Land—und Forstwirtschaft, VI. Band. 2. Heft. Berlin, 1908.

The best method to check them in nurseries is to spray in winter with paraffin jelly on the Spruce, and in spring and early summer on the Larix and Pinus. Winter spraying of Spruce with Caustic soda has also been carried out, but both host plants must be treated.

The Woolly Aphis of the Beech (*Psyllaphis fagi* Linnæus).

This Aphis was reported from several districts in and around London in 1912, as being very abundant on Copper Beech. It was also sent from Godalming in May in company with *Pseudococcus aceris* Signoret, as being very harmful to beeches forming a hedge. Specimens were also sent from

Great Lalkeld, Penrith; Worcester, Maidstone, Ramsgate, and Haddenham, Cambridgeshire.

This aphis is usually first noticed in May and is easily detected on account of the white flocculent wool it excretes, and the amount of honey dew and mealy oil-like globules it forms.

The eggs hatch towards the end of April, and the young lice at once shelter in the young opening leaves. They at this period are very pale, yellowish-green, long and narrow, and fine white filaments are soon produced. In May, after moulting, the apterous female becomes greener, and shows traces of three rows of black spots along the dorsum, and now produces a large amount of white wool beneath which it lives. When mature this viviparous female is oval and flat, with six rows of dark dorsal spots, somewhat irregular and often confluent. The winged viviparous female occurs from mid-May to mid-June. The colour is pale green to yellow-green, and is thickly covered with white flocculent matter; the head and thorax are black and the abdomen has a black band across each segment, and a row of black dots on each side; the antennæ are black; legs and eyes black, except the front femora, which are green. The wings have pale green to brown veins. The cotton is usually pure white, but is now and then a delicate blue.

These winged females fly away, where to is not known, but we certainly do not find this species on the beech again until October, when wingless oviparous females and winged males occur.

The oviparous female is shiny rich yellow or orange-yellow, and has a row of black spots on each side, and traces of grey bands on the abdomen. The winged male is a delicate pale yellowish-green aphis, covered with white powder; the head, middle of the thorax grey; the abdomen, with a row of dots on each side and short dusky bands along the dorsum. Legs pale yellow, with dusky feet, and apices to the tibiæ and femora, the hind legs being darker grey.

The female lays her eggs in November. They are yellow at first, but become shiny black. They are usually deposited on the twigs at the base of a bud, sometimes singly, at others in groups of three or four.

It is widely spread over Britain, and in some years appears in very large numbers, the under surface of the leaves becoming quite white.

I have never found any parasites upon this aphis, nor have I noticed any predaceous insects feeding upon it.

It is somewhat difficult to kill, owing to its thick woolly covering. Two sprayings are usually necessary. The wash so far found most successful is paraffin jelly with half-an-ounce of nicotine to every ten gallons of wash.

The Guelder Rose Aphis (*Aphis viburni* Scopoli).

This aphis, which is often common in the wild Guelder Rose (*Viburnum opulus*), was sent from Ireland in April. At Miltown, County Kerry, it was spoiling the Guelder Rose shrubs to a serious extent.

Mr. C. Wright, who sent the specimens, said it was occurring in such numbers that the tips of the shoots were ruined.

The Felted Beech Coccus (*Cryptococcus fagi* Barens).

This coccid seems year by year to spread from place to place and becomes more frequently enquired after and seems to be becoming more harmful.

Writing in September, Mr. H. Horden, of Throwley House, Faversham, stated that two years ago he noticed a tree with this insect on it, the tree was now dead from its attack, a well-grown Beech, nine feet in circumference.

The Sycamore Scale (*Pseudococcus aceris* Sign).

This scale insect was sent by Mr. Burgess, of Birchhanger, Godalming, in May, with information that it was killing the trees in a beech hedge. The trees were thickly encrusted with the white woolly ovisacs of this coccid, which was causing wholesale destruction.

The specimens were sent to Professor Robert Newstead, who informs me that the Beech is a new food plant for it. It is also recorded in this Report (p. 20) as attacking apple trees at Perry Court, Wye.

INSECTS INJURIOUS TO MAN'S STORES, FURNITURE, ETC.

Furniture Beetles.

The damage caused by these well known insects was reported from Hextable in July, and a full report of their workings and methods of destruction sent to the correspondent.

Another correspondent wrote from Ross, stating that some furniture brought from Venice was being ruined by the small beetles sent.

Pea Nuts Attacked by Insects.

Samples of Pea nuts were received in January from Mr. W. Voss badly attacked by the Cadelle Beetle (*Trogosites mauritanicus* Linnæus). This beetle, which attacks stores and which at the same time is also predaceous, was referred to in my last Report (p. 146).

Cachou Nuts Attacked by Insects.

Messrs. Voss and Co. wrote on January the 12th that Cachou nuts were badly attacked by some insects. The specimens sent were invaded by *Tribolium ferrugineum.*

The Meal Mite (*Aleurobius farina* Koch).

This well known mite was recorded from Elham, near Canterbury, on July 14th, as causing much annoyance by invading a dairy in great numbers. This attack has recently been investigated and will be dealt with in a subsequent Report.

Bird Seed Damaged by Mites.

A Common mite (*Tyroglyphus siro*) was reported from Dudley, Worcestershire, as occurring often in great numbers in bird seed and spoiling it for consumption. Another sample of canary seed attacked by the same acarus was sent from Nottingham.

The Parasite of the Mediterranean Flour Moth.

The parasite sent me attacking the larvæ of this moth, were named by Mr. Claude Morley, *Olesicampa flaviventris*, and were recorded as such in my last Report, p. 148. At the same time they had been sent to Mr. W. W. Froggatt, Government Entomologist, New South Wales, and were sent by him to the late Peter Cameron, who considered it a new species in the genus *Amorphota*, calling it *Amorphota ephestia*.

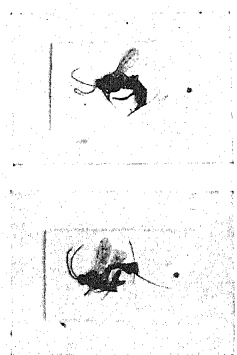

Fig. 32.
Nemeritus canescens Grav.

Under this name it is mentioned in Miscellaneous Publication, No. 1514, *Agricultural Gazette* of New South Wales, April, 1912, p. 309, in a paper on Parasitic Enemies of the Mediterranean Flour Moth.

Recently, Mr. Claude Morley has pointed out to me that its real name is *Nemeritus canescens* Grav.

It is not new to this country, for I find it has been present for some time in a bakery and out-buildings at Wye.

The Mediterranean Flour Moth was also sent from Widdington, Newport, Essex, in September, where it was occurring in bags of whole meal flour. It was also reported in abundance in a bakery at Wye, 1912, where the parasite *Nemeritus canescens* occurred and which did not seem to keep it in check at all, judging from the numbers existing.

INSECTS CAUSING ANNOYANCE TO MAN.

Mosquito Plague at Coleman's Hatch.

Considerable annoyance has been caused the last two years at Coleman's Hatch, in Ashdown Forest, Sussex, by Mosquitoes, especially at the residence of Sir Edward Hopes, K.C.B. The pests were as bad indoors as out.

In June, I visited Coleman's Hatch, to find the breeding grounds of the insects at Sir Edward Hopes' request and as a result sent the following report.

" The Mosquitoes causing annoyance are the Spotted Wing Anopheles (*Anopheles maculipennis*), which is one of the malaria carriers of Europe, North America and North Africa. It is widely spread over Britain, especially in the south and east.

" Its young stages (larvæ and pupæ) are passed solely in water—in rain barrels, small shallow natural pools, small ponds and cattle troughs, etc.

" At Coleman's Hatch, there were traces of larval and pupal exuviæ in one rain water tank, and many in a drain overflow in a meadow opposite the house. Two small pools in the meadow showed no traces of them, and the vast number of Dragon Flies and other predaceous insects in and around them make it extremely unlikely that the two ponds are a breeding place.

The ' bog-land ' in the Forest may possibly serve as a breeding ground, although I scarcely think that it does, owing to the iron in the standing patches of water and in the many swiftly running parts they cannot live.

I would advise (i.) having the rain water tanks covered with cheese cloth, so as to effectually stop the females from laying their eggs on the water and the tanks treated at the same time

with a film of paraffin oil; (ii.) that the stagnant drain overflow be opened up so as to allow it to run away.

"Should these measures fail (iii.) a few deep cut canals a foot wide below the 'bog' in the forest would cause such a flow of water, that they would not be able to breed there.

"With regards to killing them in the house, the following formula is, I think, one of the best:—Campho-phenique (Mimm's mixture). Mix equal weights of camphor and ninety-five per cent carbolic acid and place 4-ozs. of the mixture on shallow pans, one for each 1,000 cubic feet of space to be fumigated and subject this mixture to the heat of an alcohol lamp. It has the advantage of being cheap, very efficient and is non-objectionable."

The first two recommendations were soon carried out, and as they proved to be sufficient, nothing was done to the "bog-land." No mosquitoes had appeared again by the autumn.

One noticeable feature was the great wealth of insect life in and around the two pools in the meadow. Countless Odonata, were flying over and around them and were locally called "Sketer Hawks," on account of their larvæ feeding on the mosquitoes in the water. Great numbers of water gerris and water beetles (*Dytiscus*) occurred in the ponds, and also Trout, which would speedily destroy any larvæ that might occur in the shallow edges.

Mosquito Plague at Worcester.

In September, another mosquito plague was complained of from Worcester, Mr. J. Mason writing that the house was full of the annoying biting flies sent. These proved to be the common Brown or Household Mosquitoes *Culex pipiens* Linnæus; which is to be found all over Britain. In some districts this mosquito does not seem to bite humans at all, in others it does so at certain times of the year annually, in others it appears only to bite now and again. What regulates this erratic human blood-sucking habit I have failed to elucidate. I remember being badly bitten by them in Essex, on two occasions and also in Norway, but I have never known them to bite at Wye, and yet they occur in countless numbers

indoors in certain years. The bite is painful, but I have never seen it produce the large wheal that follows the bite of *Theobaldia annulata* and *Culicada cantans* or the severe pruritis caused by *Grabhamia dorsalis* Meigen or *Pseudo-taenioraynchus Richardii* Ficalbi in the Norfolk Fens. The Brown Household Mosquito lays its eggs in rafts on the water in rain barrels, small pools in gardens, tanks, foul water in in cess pits and even in the cisterns in houses, in fact any artificial collection of water. The larvæ and pupæ are found in the water during the whole of their existence. The adults hatch any time between June and October and several broods may occur, as many as four having been bred at Wye. The adults hibernate in cellars, privies, out-houses, lofts and where-ever they can find shelter and may be seen on the wing indoors on warm days in winter. The females only hibernate as with the *Anopheles maculipennis* and are fertilized in the autumn by the males. A meal of blood is necessary before the female anopheles deposits her eggs, but with the *Culex pipiens* I find this is not necessary, for I have several times kept hibernators taken from my cellar fed only on banana slices and have reared the insects from their ova.

The same methods of prevention and destruction apply for this insect as for the Anopheles, but one must bear in mind that it breeds in some different places, notably in cisterns indoors.

Red Mites (*Dermanyssus avium* Redi) on Cage Birds.

This bird pest was reported from Dudley, Worcestershire, a bird expert saying that they were very annoying to cage birds, especially canaries.

Extra British Enquiries.

The following enquiries have been received and information sent during the year.

1. Seeds of *Caesalpinia digyma* from Burma attacked by Insects from the Imperial Institute. They were attacked by a *Bruchus* sp. ?

2. Cocoanut plantations attacked by the Rhinoceros Beetle (*Oryctes rhinoceros*) with especial reference to the des-

truction of old stumps and refuse, from the Imperial Institute. Recommendation was made to try Mr. F. Jepsons' plan of pits of refuse to attract the beetles and then the injection of disulphide of carbon to kill the larvæ.

3. Pepper Trees attacked by *Lecanium hæmisphæricum* at Peniche in Portugal. The trees have been annually coated with this scale, some of the specimens sent being so thickly packed together that no trace of the wood could be seen. Considerable damage was caused by it. There appears to be no parasite affecting it at Peniche (Fig. 33).

Fig. 33.
Lecanium hæmisphæricum. Targ-Tozz.

The usual methods of scale treatment were forwarded.

4. From Buenos Ayres information was sought concerning the treatment of the Scale Insect (*Diaspis pentagona*), which was badly damaging peaches. Lime-sulphur spraying was in vogue there, but did not seem to affect this pest. Spraying with paraffin jelly was advised in the dormant season.

5. In August, Mrs. H. Dalrymple wrote from St. Jean de Luz, Basses Pyrénées, for information concerning the economy of a Myriapod (*Scutigera variegata* Koch ?) often found in an hotel.

This arthropod belongs to the order Schizotarsia of the Myriapoda and to the family *Cermatiidæ*, which have long multi-articulate legs, a pair to each body ring. These creatures are unknown in Britain, but are common in parts of Africa and in some of the Mediterranean countries. They are found running on stones and the walls of houses as a rule, and no doubt frequently enter the latter. They feed upon insects and hunt during the

day-time and have large eyes, the only Myriapoda with facetted eyes.

The bite of these animals, as pointed out by Latreille, is undoubtedly poisonous.

Frog Hopper Blight in Trinidad.

A visit was paid by one of the Directors of the Trinidad Estates Company in July, concerning the damage caused by the Frog Hopper (*Tomaspis varia* Fabr.) to sugar cane in that island and a considerable amount of correspondence entered into concerning it.

Several of the most likely methods of dealing with it were given and are being carried out.

As this pest is mainly terrestrial, its aerial life, at least when it can be coped with, being very short, the experiments in regards to spraying needless to say have proved of no avail, and if they could be carried out practically would be mere waste of money.

Shade Trees attacked by Insects in Cairo.

Specimens of damaged leaves, etc., from shade trees in Cairo were sent by Mr. W. Voss on January 19th. The leaves were coated with the white Cushion Scale (*Icerya ægyptica*).

The Cotton Boll Worm (*Earias insulana*).

Specimens of damaged cotton bolls were received from the Imperial Institute in March. The appearance was exactly that produced by the Cotton Boll Worm (*Earias insulana*), and later this was found to be the culprit.

The specimens came from Eritrea, where cotton had been grown for the first season.

A Poplar (*Pemphigus brusarius*) Gall in Cairo.

Specimens of galls on poplars were received from Mr. F. Willcocks in January, for identification. They proved to be the *Pemphigus brusarius*.

This Aphis has frequently been recorded as British, but I have only seen two galls of it in this country, where it is apparently very uncommon. Most of the records of it by Connold, Buchton, and others refer to *Pemphigus pyriformis*.

A Fruit Fly (*Drosophila amphelophila*) in Cairo.

Some flies attacking fruit were received in October from the School of Agriculture in Cairo, sent by Mr. J. R. Davidson. They proved to be the *Drosophila amphelophila*. It was said that they had been mistaken by people for the Mediterenanean Fruit Fly (*Ceratitis capitata*). Mr. Davidson wrote that " It is doing a tremendous amount of damage to our fruit trees, guavas, dates, oranges, pomegranates, etc."

Camels attacked by Ticks.

A communication was received in March from Captain Reginald Hart, Commander of the Camel Corps, Bara, Sudan, concerning the great annoyance caused to the camels by what are called " Heim."

Numbers of living and preserved specimens were sent and proved to be the Tick known as *Ornithodorus moubata*. These I kept alive for nearly a year without any food.

Captain Hart wrote that " the Ticks are an awful nuisance and generally collect in places that have been inhabited a long time and not kept clean. The soil where they occur is a deep loose sand, and there is no vegetation about. The 'Heim' is a small species of Tick, about the size of a pin's head. It abounds in the sand where the animals have been kept for a long time and where the ground has been allowed to get dirty. This Tick burrows down into the sand for about two feet, and when animals or men stand about on the infected ground they come up to the surface and bite them, and soon from the size of a pin's head inflate themselves to that of a threepenny piece. It appears to burrow into the sand to escape from the heat of the sun. The bites inflicted by them are very painful. Animals will not lie down on infected ground, but stand up and stamp their feet, often breaking loose and stampeding. Camels are the animals I chiefly refer to.

If there is any shade, such as bushes, the 'Heim' is very fond of living in them. They do not travel, it appears, as one place may be stiff with them, whilst a few yards away the country is quite free of it. It appears to be carried by the animals."

An acccount of this widely distributed Tick in Africa was sent as requested, and the matter was referred to Mr. King, the Government Entomologist.

One point may be mentioned, as I wished these Ticks to breed and so obtain the eggs, I placed in one of the jars a mouse, with the hopes that they would feed on it, but instead of the Ticks feeding on the mouse, the mouse ate all the Ticks, devouring them with evident delight. They remained for the most part buried in the sand in a dormant state, but soon after one put one's hand into the jar they scurried out of the sand with great rapidity.

Spraying of Fruit Trees.

Enquiries concerning the spraying of Fruit trees were received from Mr. John Black, of Atawhai, Auckland, New Zealand, in May, and from Mr. S. Cochran Macky, of Devonport, New Zealand, in the same month.

NOTES ON THE CHIEF INSECTS AFFECTING FOREST TREES IN GREAT BRITAIN.*

BY C. W. JEMMETT, F.E.S.
(*Late Government Entomologist, Southern Nigeria.*)

LIST OF INSECTS DEALT WITH :

Lepidoptera :

Goat Moth (*Cossus ligniperda*) attacks trunk.
Winter Moth (*Cheimatobia brumata*) attacks foliage.
Brown Tail Moth (*Euproctis chryssorhœa*) attacks foliage.
Black Arches Moth (*Liparis monacha*), attacks foliage.
Green Oak Tortrix Moth (*Tortrix viridana*) attacks foliage.
Larch Coleophora (*Coleophora laricella*) attacks needles.

Coleoptera :

Pine Weevils (*a*) (*Hylobius abietis*) attacks young shoots.
(*b*) (*Pissodes notatus*) attacks bark and wood.
Pine Beetle (*Hylurgus piniperda*) attacks shoots.
Spruce Bark Beetle (*Tomicus typographus*) attacks bark.
Ash Bark Beetle (*Hylesinus fraxinus*) attacks bark.
Elm Bark Beetle (*Scolytus destructor*) attacks bark.
Cock Chafer (*Melolontha vulgaris*) attacks roots and foliage.

Hymenoptera :

Wood Wasps (*Siricidæ*) attack wood.
Pine Sawflies (*a*) (*Lophyrus pini*) attacks needles.
(*b*) (*Lophyrus rufus*) attacks needles.
Larch Sawfly (*Nen atus erichsoni*) attacks foliage.
Douglas Fir Seed Fly (*Megastigmus spermatrophus*) attacks seeds.

Hemiptera :

Spruce Gall Aphis, Larch Aphis, etc. (*Chermesinæ*) attack bark and needles.
Ash and Willow Scale (*Chionaspis salicis*) attacks bark.
Felted Beech Coccus (*Cryptococcus fagi*) attacks trunks and branches.

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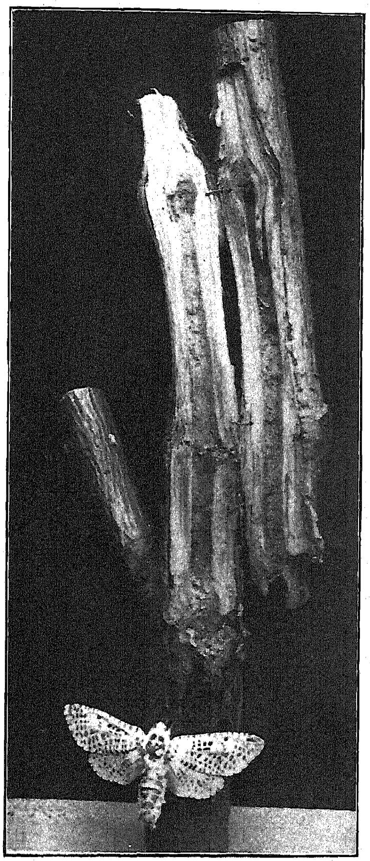
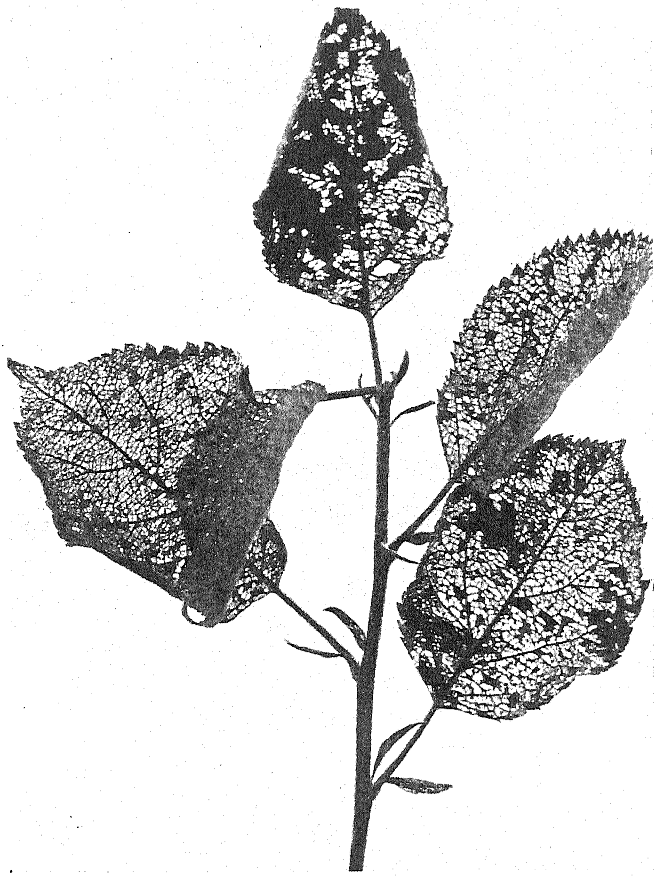
* *A Pamphlet on this subject may be obtained, price 6d., by residents in Kent or Surrey on application to the Secretary of the College. Price to non-residents, 1s. 6d.*

PLATE I.



WOOD LEOPARD MOTH
and Damaged Pear Shoot (Half natural size).

PLATE II.



APPLE FOLIAGE DAMAGED BY YOUNG GOLD-TAIL MOTH LARVÆ IN AUTUMN.

PLATE III.

[F. Edenden.

DAMAGE DONE TO APPLE SHOOTS BY GREEN BUGS AND YELLOW SPRINGTAILS.

PLATE IV.

THE WHITE WOOLLY CURRANT SCALE (*Pulvinaria vitis*, v. *ribesiæ*).

PLATE V.

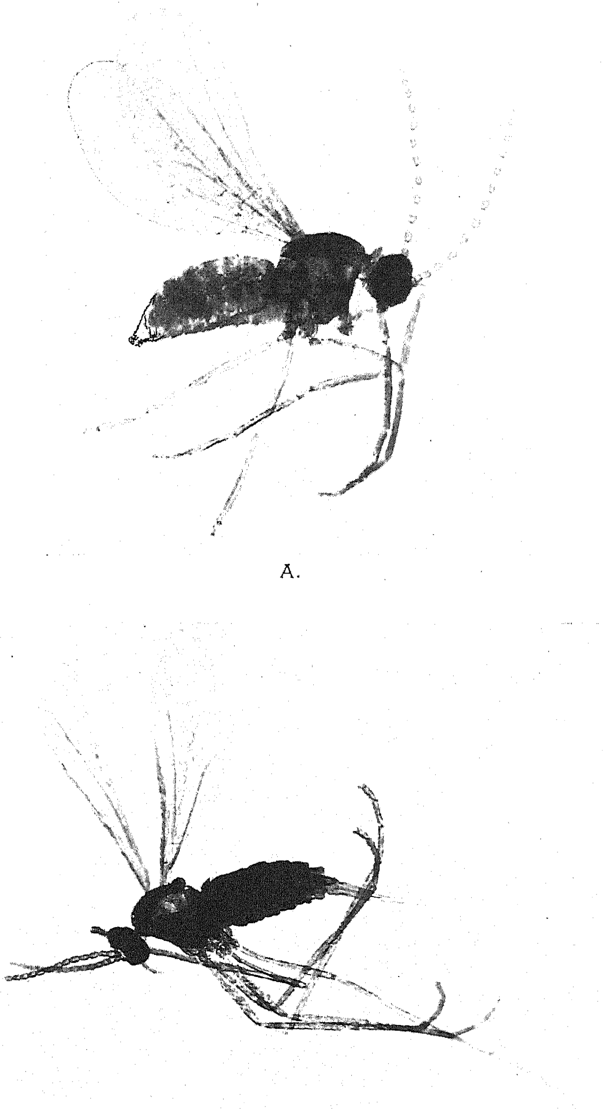
THE WHITE WOOLLY CURRANT SCALE (*Pulvinia vitis* v. *ribesiæ*).

PLATE VI.

[F. Edenden.

CURRANT SHOOT DAMAGED BY GREEN BUGS AND SPRINGTAILS.

PLATE VII.



A.

B.

THE PEAR LEAF CURLING MIDGE (*Cecidomyia pyri* Bouché.)
A. female. B. Male, greatly enlarged.

PLATE VIII.

RASPBERRY SHOOT ATTACKED BY A DIPTEROUS MAGGOT.

PLATE IX

PEA LEAVES AND HAULM, attacked by *Phytomyza pisi*.
A. shows damage to the haulm.

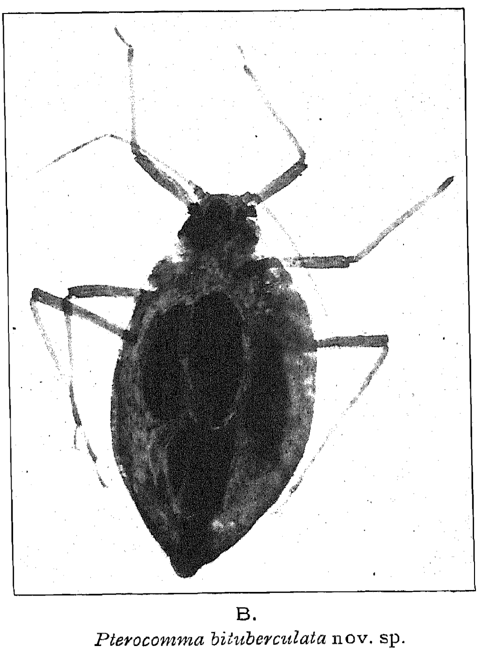
PLATE X.

(De'Ath.)

LARVÆ OF THE ASPARAGUS BEETLE AT WORK.

PLATE XI.

A.



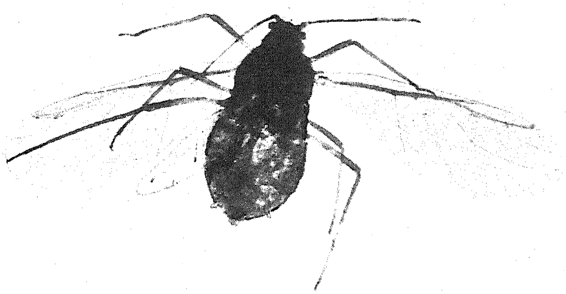
B.

Pterocomma bituberculata nov. sp.

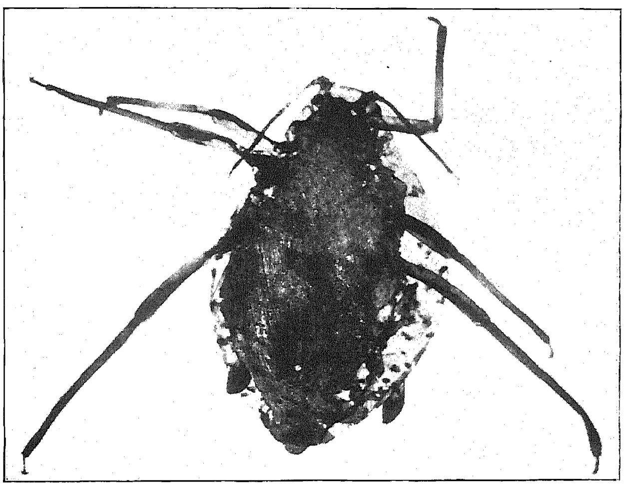
A. Male. B. Ovigerous Female.

A. magnified twenty-three times. B. magnified eighteen times.

PLATE XII.



A.

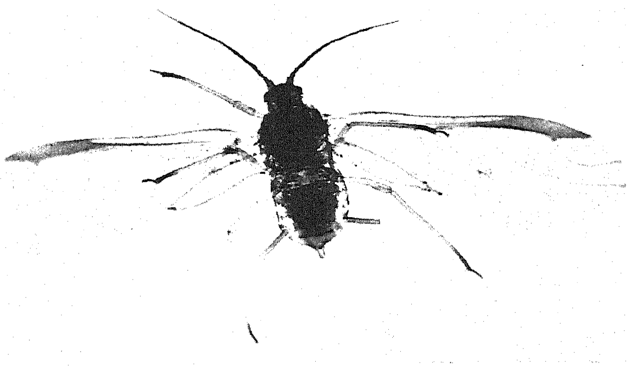


B.

A. Alate Female of *Pterocomma bituberculata* nov. sp.
B. Apterous Female of *Melanoxantherimu salicis* Linnæus.
A. magnified ten times. B. magnified sixteen times.

PLATE XIII.

A.



B.

APTEROUS A, AND ALATE FEMALE B, OF *Aphis saliceti* Kaltenbach.
A magnified twenty-seven times. B twelve times.

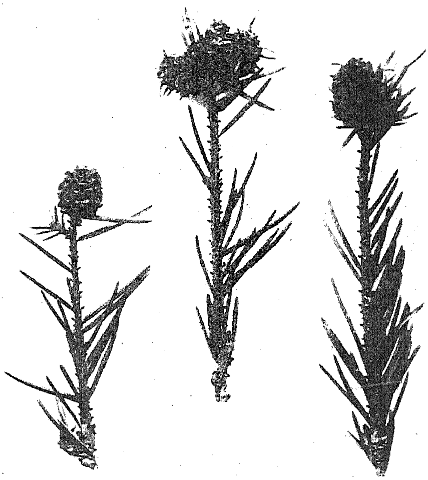
PLATE XIV.

A.

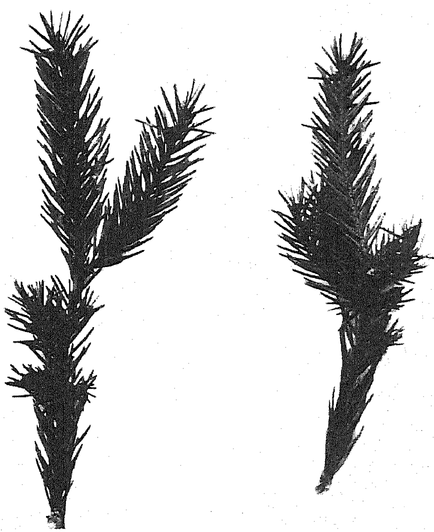
B.

APTEROUS A, AND ALATE FEMALE B, OF *Siphocoryne capreæ* Fabricius.
A magnified twenty-five times. B magnified fourteen times.

PLATE XV.



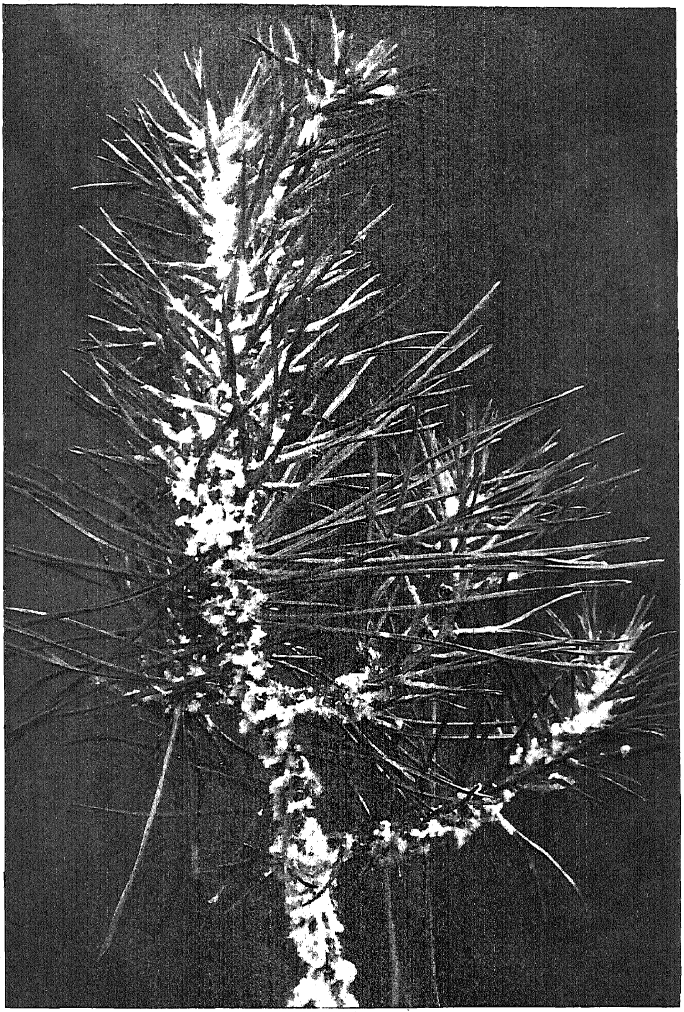
A.



B.

A. GALL OF *Cnaphalodes strobilobius* Kaltenbach on *Picea excelsa*.
B. GALLS OF *Pineus pini* on *Picea excelsa*. Half natural size.

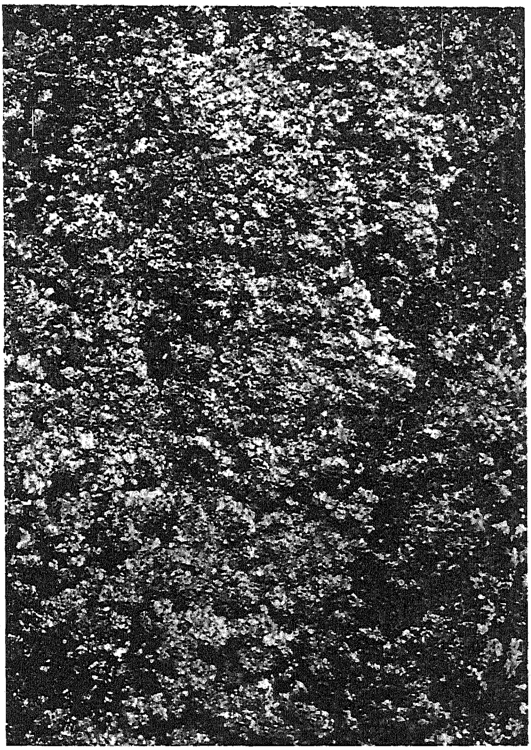
PLATE XVI.



[F. Edenden.

SCOTS FIR (*Pinus sylvestris*) attacked by *Pineus pini* Linn.

PLATE XVII.



THE FELTED BEECH COCCUS (*Cryptococcus fagi* Barens).

REPORT FROM THE

CHEMICAL DEPARTMENT.

BY

D. R. EDWARDES-KER, B.A. (OXON), B.SC. (LOND.)

PAGE

TENTH REPORT

FROM THE

ANALYTICAL LABORATORY

BY

R. H. CARTER, M.S.E.A.C.

This report covers the period from September 30th, 1911, to March 31st, 1913, during which time 813 samples were received for analysis. Of these, 488 were sent in by farmers in Kent and Surrey, and comprised the following:—

Manures	.. ..	151 samples.
Feeding Stuffs	.. .. ..	51 ,,
Soils	.. ..	58 ,,
Milks	.. ..	182 ,,
Waters	.. ..	17 ,,
Miscellaneous	.. .. ..	29 ,,
Total	.. ..	488 ,,

The remaining 325 samples were examined in connection with experimental work carried out by other departments of the College, and included 229 samples of milk, 13 of Feeding Stuffs, 13 of Tobacco, 20 of Hops, 32 of Soils, and 18 of miscellaneous substances. These analyses will not be further mentioned, as the results are discussed in other sections of this *Journal*. Also, in accordance with the practice of former years, this report is to be taken as supplementary to preceding reports issued from the analytical laboratory, and the descriptions of manures, feeding stuffs, and other substances given in the earlier reports are not repeated.

It is satisfactory to be able again to record an increasing tendency on the part of farmers in the Counties to take advantage of the facilities offered by the College, particularly with regard to the analysis of Feeding Stuffs and Manures. During the eighteen months under review, 202 samples of these materials were received, as against 78 in the preceding twelve months. In the case of other substances examined, the numbers have maintained the level noted in the last report, in which was recorded a considerable increase over former years in all classes except milks. This year there has been no further decrease in the number of milk samples received.

The total lack of information accompanying the majority of the samples sent to the College was discussed at some length in the previous report, and the desirability of forwarding full particulars was emphasized. Unfortunately little or no improvement in this respect can be chronicled for the past year. Many samples were received accompanied by nothing more than a request for analysis—notwithstanding which, the senders would, in all probability, have experienced considerable annoyance if the analysis alone, without any further information, had been forwarded in reply. It is frequently quite impossible to state definitely the value of any particular substance, or to indicate the best means of employing it, unless some information is supplied as to the purpose for which it is intended, and the conditions under which it may have to be used.

MANURES.

Out of a total of 151 samples received, only nine were of the standard artificial manures, and these were in all cases up to their guarantees. A few mixed manures were also examined, but the majority of the samples consisted of waste organic substances and other refuse materials, which are largely used in the intensively cultivated hop gardens of Kent and Surrey, and in other cases where organic manures are needed, but where a sufficiency of dung cannot be obtained.

SHODDY, FLOCK DUST, ETC.

No really high-grade shoddies were received, although forty-seven samples were examined. The greater number were

of medium grade, with a Nitrogen content ranging from 4 per cent. to 7 per cent., and a moisture content averaging 11 per cent. The moisture content has not shown any great variation this year—only two samples were unsatisfactory in this respect, containing 17.9 per cent. and 23 per cent. of water—and the mechanical condition has been very good. The Flock Dusts, as usual, proved to be in a much finer state of division than the shoddies. Analyses of a few of the more interesting samples are given below.

TABLE I.

Ref.	Description.	Moisture.	Nitrogen.	Equiv. to Ammonia.	Sand.
189	Shearings	12.12	3.57	4.34	19.48
194	Shoddy Powder	21.57	1.74	2.11	10.28
469	Treated Shoddy	23.34	1.76	2.13	—
471	Cotton Waste	—	.23	.28	7.67
529	Cloth Bits	12.67	8.54	10.37	—

No. 189 was sent in under the name of "Shearings," and consisted of tags of fleeces, mixed with a considerable proportion of earthy matter. In addition to the figures given above, the sample contained 8.6 per cent. of fat and oil, and 1.5 per cent. of potash. It was in a very coarse condition, and the high proportion of sandy material present reduced its value. The hop grower who sent it for examination was able to obtain considerable quantities locally, and provided that it could be purchased at 5s. or 6s. per unit of nitrogen it would certainly be a useful manure for hops. The question of the effect of oily material in manures was mentioned in the last report (p. 10).

"Shoddy powder," No. 194, was a black, moist powder, claimed to have been specially treated in order to render the nitrogenous substances readily available for the use of plants. The organic material had been mixed with some phosphatic substance, for the sample contained 11.04 per cent. of

phosphates (calculated as tricalcic phosphate) some of which were soluble in 2 per cent. citric acid. A certain amount of salt was also present. The analysis suggested a possible admixture of superphosphate and lime, with shoddy dust; but, however prepared, the sample did not appear to be a particularly valuable manure. A small proportion (0.3 per cent.) of ammoniacal nitrogen was certainly present, but this represented only a fraction of the total nitrogen, and the nitrogenous compounds in themselves constituted but a small percentage of the whole material.

No. 469. This was another "treated" shoddy, in which sulphuric acid was the agent employed to break down the nitrogenous matter. It is doubtful whether sulphuric acid does actually quicken the decay of organic matter, and, in any case, the shoddy is rendered not only distinctly acid and unpleasant to handle, but its mechanical condition is not improved. This particular sample was of poor quality, and its acid nature would render its use very undesirable on soils deficient in lime.

No. 471, a sample of Cotton Waste, was very similar to other samples which were described in the last report, and was valueless as manure. It is difficult to see in what way such material could be employed advantageously on the farm, even if procurable for the cost of carting alone. As litter it does not appear likely to prove at all satisfactory—in fact, its use for this purpose might even be dangerous, for if any were eaten by stock fatal results would probably ensue. It is conceivable that in some instances it might be found of use as a means of absorbing liquid manure, or possibly it might be employed for a similar purpose at the bottom of mixens. In any case, its value in these directions would certainly not recompense the farmer for the cost of carting over any considerable distance, much less justify his seriously considering the price asked, 15s. per ton.

No. 259, consisting of Cloth bits, was in some respects the best sample of the shoddy type received during the period. It was remarkably clean, and—as has been noted previously in the case of the better class shoddies—rather highly coloured. As the name implies, it was not shredded, and on this account would probably prove to be very slow in action.

WOOL WASTE.

The number of Wool Wastes received this year has been greater than usual, and considerable variations in composition have been noted. Their condition, on the whole, has been superior to that of the shoddies, but their quality distinctly poorer, on account of the higher proportion of sand and dirt contained.

Ref.	Description.	Moisture.	Nitrogen.	Equiv. to Ammonia.	Sand.
180	Australian Wool Waste	—	5·13	6.23	7.60
512	,, ,, ,,	—	4·83	5·87	9·42
530	,, ,, ,,	—	3·76	4·56	—
237	Raw Fleece Combings	9·72	4·39	5·33	13·91
350	Wool Waste	8.00	7·26	8.81	—
539	,, ,,	11·72	9·78	11.88	—
532	,, ,,	10.66	5·81	7·03	11·70
266	,, ,,	26·51	2.80	3·40	17·35
536	Prepared Wool Waste	4·46	2.60	3·16	47·15

Several samples of Australian Wool Waste, *e.g.*, Nos. 180, 512 and 530, were very similar to one another both in appearance and composition. All contained a considerable admixture of Lucerne and other leguminous seeds. They were in excellent mechanical condition, and very free from moisture. The Raw Fleece Combings, No. 237, closely resembled them, but contained more dirt.

Nos. 350 and 539 were particularly clean and dry—the latter was the best sample we have received for some time. No. 532 was not so satisfactory—it was very lumpy, also rather greasy. No. 266 was an inferior sample—it was very moist

and contained much sandy matter, in addition to a considerable quantity of coal dust. It was partly decomposed.

Sample No. 536, stated to be a Prepared Wool Waste particularly useful for hops and roots, was offered at 65s. per ton, delivered to user's station. So far as could be seen, the "preparation" had necessitated the addition of such large quantities of earthy material that the sample no longer resembled a wool waste, and could very easily have been mistaken for air-dried soil. It contained 40.5 per cent. of organic matter, and 47 per cent. of sand. Traces of phosphates, and 0·42 per cent. of potash were also present. The nitrogenous substances appeared to exist in a partly decomposed condition, since a small quantity of ammonia was evolved on distillation with dilute alkali. The sample, however, could in no sense be considered a wool waste, and the price asked was grossly excessive. The unit of nitrogen in such inferior material cannot be considered worth more than 5s. at the most (the present price in good medium-grade shoddy is about 8s. 6d.), whereas the price actually demanded approximated to 20s. per unit.

FUR WASTE, HAIR WASTE, ETC.

Ref.	Description.	Moisture.	Nitrogen.	Equiv. to Ammonia.
326*a*	Feather Quills	—	12.45	15.11
326*b*	Feather Dust	—	6.60	8.01
446	Seal Fur Waste	9.76	13.29	16.13
447*a*	Seal Fluff	10.02	9.30	11.29
447*b*	Calf Hair	10.30	9.52	11.55
477	Camel Hair Waste	—	3.30	4.01
597	Hair Refuse	23.01	3.62	4.39

The Hair Manures examined have, for the most part, been in exceptionally good condition. Usually the mechanical

condition is very bad,—the matted, lumpy state in which many fur and hair wastes are obtained detracting materially from their value. In the above table a few examples are quoted, and the analyses of two Feather Wastes have been included. Samples of such material do not often reach us ; it is known to be a good manure for hops, and the limited supply is readily bought up.

No. 326 consisted of rather large feathers, and would be much slower in action than 326*b*, which was mainly composed of down. No price was mentioned, but feather wastes can often be obtained at from £5 to £6 per ton, delivered. The percentage of nitrogen in 326*a* is rather higher than usual.

Seal Fur Wastes, Nos. 446 and 447*a*, were very clean and in excellent condition, No. 446 being one of the best Fur Wastes we have seen.

Nos. 477 and 597 were of very inferior quality ; the Camel Hair Waste was composed of coarse material, and contained much dust, wood shavings, and other useless matter, while the Hair Refuse was moist, and mixed with a considerable quantity of gypsum and calcium carbonate. The latter was probably a Tannery Waste.

HOOF AND HORN WASTES.

When well ground, hoofs and horns form valuable nitrogenous manures, and are much used by market gardeners and the manufacturers of compound manures. In an unbroken condition they are of little value, owing to their extreme slowness of action, and we are frequently unable to recommend samples on this account.

Refs.	Description.	Nitrogen.	Equiv. to Ammonia.
359	Hoof and Horn	13.43	16.31
447	Hoofs	13.75	16.69

No. 359 was a good sample, very well ground. No. 447 consisted of unbroken sheep hoofs. They were offered as hop manure, and the purchaser feared, from their appearance,

that they had been charred. There was nothing abnormal, however, in the black appearance, and the nitrogen content was satisfactory, but unless they were finely ground before application to the gardens little return could be expected from their use.

GUANOS, FISH MANURES, ETC.

(See Table, p. 233).

In our last report we had occasion to remark upon the deterioration in quality of the samples of Fish Manure examined, compared with those received in previous years. This year, again, none of the best quality Fish Guanos have reached us, and the majority of the samples sent in were of a distinctly inferior type. Nos. 272 and 619 are typical of a number received. The former was quoted at £4 17s. 6d. per ton, delivered, and the latter at £3 6s. 6d. Both had been treated with sulphuric acid, and contained 4.4 per cent. and 5.45 per cent. of water soluble phosphate respectively. They were up to their guarantees, but the prices were excessive. No. 205 was a much better sample, but considered as a Fish Guano it was of low grade, and contained a high percentage of mineral matter.

Although the Fish manures sent to us were of such poor quality, considerable quantities of high grade Fish Guanos were offered on the markets, and found a ready sale. There is no reason to suppose that this manure has lost any of its popularity amongst hop-growers, but the price of good samples is high, and its use is limited on that account. Doubtless, if it were obtainable at cheaper rates it would be more extensively employed, for on the lighter soils it gives excellent results. It may be hoped, however, that lower prices will ultimately prevail, for recently several new factories have been erected in various parts of the country with the object of dealing with fish refuse and meat offals, and it is expected that further developments in this direction will take place. Unfortunately, considerable opposition on the part of town councils and sanitary authorities has hitherto been encountered in the establishment of these factories, but the introduction of the Schirm process, in which all operations are carried out in a completely closed system,

GUANOS, FISH MANURES, ETC.

Ref.	Description.	Nitrogen.	Equiv. to Ammonia.	Phosphoric Acid.	Equiv. to Tricalcic Phosphate.	Potash.	Moisture + Organic Matter.	Sand.
205	Fish Guano ..	3.99	4.84	3.96	8.65	—	—	25.61
272	Fish Manure ..	1.40	1.70	2.80	6.20	—	30.61	—
619	,, ,, ..	1.97	2.40	4.48	9.77	—	41.96	—
595*a*	Meat Guano ..	6.08	7.38	6.96	15.23	—	76.40	2.77
595*b*	,, ,, ..	6.23	7.57	5.50	12.01	—	76.86	3.93
622*a*	,, ,, ..	6.02	7.30	13.62	29.74	—	64.46	1.52
622*b*	,, ,,	7.85	9.53	6.90	15.07	—	75.63	1.53
626	,, ,,	5.96	7.23	9.26	20.21	—	63.70	8.70
378	Raw Peruvian ..	10.37	12.59	12.12	26.47	3.15	49.84	6.66
405*a*	,, ,, ..	11.83	14.37	9.22	20.14	2.22	55.82	17.52
405*b*	Dissolved Peruvian ..	5.70	6.92	11.20	24.47	2.17	44.58	3.33

should greatly tend to lessen such opposition in future. Enormous quantities of fish and meat offals are still annually thrown into the sea, and the prevention of such waste is a matter of serious importance.

The Meat Guanos quoted in the table do not require special mention. They were all satisfactory samples of the higher grades, and from prices quoted the unit value of the nitrogen appeared to be about 13s., and of the phosphate about 10d., for deliveries ex. rail, London.

Two samples of Raw Peruvian Guano, Nos. 378 and 405*a*, were examined and proved to be good quality nitrogenous guanos. No. 405*a* contained a rather high proportion of mineral matter. In both samples about half the nitrogen was present in easily soluble forms.

No. 405*b* was a Dissolved Guano. It was in good condition, free from lumps; practically the whole of the nitrogen was in the form of sulphate of ammonia, and 20.1 per cent. of the phosphate was soluble in water. The prices of these guanos were not mentioned, but from quotations given last year to the College it appeared that the market value of nitrogen in high grade nitrogenous guanos was very nearly 18s. per unit.

BONE MANURES.

Like the majority of the substances previously mentioned, Bones and Bone Manures are largely used in the hop gardens and fruit plantations of Kent and Surrey. Full descriptions of the various products on the market, with details as to their methods of manufacture, have appeared in previous issues of this report (*vide* this *Journal*, Nos. 12 and 15.) A number of samples were analysed last year, and a few of the more interesting results are given in the following table :—

(See Table, p. 235).

A great demand exists for the best quality Bone Meals, and prices rule high. No. 621 is representative of several samples received, and was offered at £6 5s. per ton. Like others, it was exceptionally clean, but the fineness of grinding left something to be desired. We have remarked before that, of the Bone Meals which have come to our notice, those con-

BONE MANURES.

No.	Description.	Nitrogen.	Equiv. to Ammonia.	Phosphoric Acid.	Equiv. to Tricalcic Phosphate.	Moisture + Organic Matter.	Sand.
427	Bone Meal	4.29	5.20	17.27	37.70	—	1.02
621	,, ,, ...	5.13	6.22	19.76	42.13	50.92	.51
613	Bone Refuse	2.28	2.77	19.90	43.50	30.68	7.16
191	Dissolved Bones	2.91	3.53	17.68	38.57	38.12	2.12
435	"Calcined Bones"	.61	.74	12.41	27.13	38.24	23.92

taining the highest percentages of nitrogen appeared considerably coarser than others containing 4 per cent. or under, and it is probable that the former are manufactured direct from raw bones, which cannot be ground so finely as those which have been subjected to a preliminary steaming at low pressures.

No. 427, a lower grade sample, contained less phosphate than is usually present in bone meal. It appeared, however, to be perfectly genuine, and the bulk was in a fine state of division.

A sample of Dissolved Bones, No. 191, thought by the purchaser to be much adulterated, was a genuine sample, which had evidently undergone considerable reversion on storage; 29 per cent. of the phosphate was soluble in 2 per cent. citric acid, but only 4.12 per cent. was soluble in water, whereas in a fresh sample rather more than half the total phosphate is soluble in water.

No. 613 would probably be of use if obtainable at a low price, but it was essentially a refuse manure, in very coarse condition. The bones had undergone a certain amount of decay, with consequent loss of nitrogen compounds.

The remaining sample quoted—No. 435—was some form of Spent Bone Black, which apparently had been employed in the refining of tallow or grease. It contained a considerable quantity of sand, and as much as 25 per cent. of fat. The presence of so much fatty matter was remarkable, and certainly could not be considered at all desirable in a manure. The term "Calcined Bones" was misleading, for freshly calcined bones form a much more valuable manure than the sample in question, since they are approximately three times as rich in phosphates. For the sake of comparison, the following analyses of Fresh Bone Black and also of Spent Char from sugar refineries are given below:—

	Nitrogen.	Equiv. to Ammonia.	Phosphoric Acid.	Equiv. to Tricalcic Phosphate.
Fresh Bone Black	1.0	1.21	36.0	78.5
Spent Char	1.5 to 2	1.8 to 2.4	27.5 to 32	60 to 77

Bone Char (or animal charcoal) is much employed as a decolorising agent, largely in sugar refineries. It can be used for a considerable time without losing its power of absorbing organic colouring matter, but ultimately it becomes of no further use, and the spent char is then converted into phosphatic manures, chiefly bone superphosphate.

MISCELLANEOUS WASTE SUBSTANCES.

Numbers of these materials, of the most varied description, are sent in to us annually, and it is evident that some, at any rate, are of distinct use to the farmer. We have reason to believe, however, that in many cases the prices paid for them are much in excess of their real money value. Some farmers are still inclined to regard any organic refuse as infinitely superior to manufactured manures, and are willing to pay for it accordingly. It is as well to remember that the majority of such wastes as we are considering do not contain much material of direct fertilizing value, and that their mechanical condition too often leaves much to be desired. Their chief function, of course, is to assist in maintaining the supply of humus in the soil, and in this respect the mechanical condition is a factor of great importance. The substances of which they are often largely composed decay but slowly in the soil, and are not likely to be of much use unless they can be applied in a finely divided condition.

The valuation of these wastes is a matter of considerable difficulty, and it does not seem possible to devise a really satisfactory method. Bulks are often not uniform, and the difficulty of obtaining representative samples for analysis is so great that as a rule no guarantee of composition can be given.

Town Refuse.

Mountainous collections of household waste—the contents of the domestic dustbin—are to be found in the vicinity of most towns, and its disposal, or destruction, is frequently a problem of considerable difficulty, often entailing great expense. Sometimes the material is offered as manure to neighbouring farmers for the cost of carting, and on the Continent seems to enjoy some degree of popularity. Several

samples have reached us in the course of the year, and an account of these is given below :—

London Refuse.—Two samples were received, one being drawn from a heap of fresh material, recently deposited, and another taken from a mass twenty to thirty feet deep, covering several acres in extent, which had been nearly three years in storage. It was stated that the processes of decay which took place during the storage greatly enhanced the manurial value of the refuse, and the practice of storing was on this account considered necessary by local farmers. On the other hand, the existence of such unsavoury, rat-infested, and fly-breeding deposits was a source of great annoyance to other residents, and was considered by the medical authorities to be most detrimental to health. Owing to the condition in which these samples arrived, direct sampling for analysis was impossible, as we had at our disposal no appliance which could break down the heterogeneous collection of tins, bottles, stones, etc., which the material contained. Recourse was therefore had to a system of sieving, and the finer portions only were analysed. The fractions separated by the sieves could not possess any direct manurial value, as a consideration of their character will show :—

	Crude Refuse.	Decayed Refuse.
Material separated by ¾ in. sieve	30.90%	10.72%
,, ,, ,, ¼ in. ,,	26.61%	29.36%
Total rejected	57.51%	40.08%
Residue analysed	42.49%	59.92%

Character of these portions :—

I.—Separated by ¾-inch Sieve.

(*a*) Crude Refuse :—The material held upon the sieve consisted of paper, tins, bones, cotton rags, together with large pieces of glass, slate, earthenware, coal and cinders—about 31 per cent. of the whole by weight.

(*b*) Decayed refuse :—The portion separated formed about 11 per cent. of the whole. It contained no tins nor organic residues, but in other respects was similar to the material removed from the crude refuse.

II.—Separated by ¼-inch Sieve.

In both samples this fraction consisted of small pieces of coal, cinders and earthenware. The percentages present were almost identical in the crude and decayed wastes.

The results obtained by chemical analysis of the fine material were as follow :—

Ref. No.	Crude Refuse.		Decayed Refuse.	
	Per cent. on Fine Material.	Per cent. on Original Sample.	Per cent. on Fine Material.	Per cent. on Original Sample.
Moisture	26.53	—	23.28	—
Organic matter	20.13	—	19.53	—
*Nitrogen	.52	.22	.58	.35
Phosphoric acid (total)	.51	.22	.40	.24
,, ,, (available)	.09	.04	.21	.12
Potash (total)	.53	.23	.41	.25
,, (available)	.03	.02	.04	.02
Ash	53.34	—	58.19	—
,, containing sand	28.20	—	31.96	—
*Containing Nitrogen obtained as ammonia by distillation with alkali	.05	.02	.08	.05

The figures for "available" potash and phosphoric acid were obtained by Dyer's method for soil analysis. It is apparent that the actual fertilizing value of these samples was extremely small. In addition to the worthless material separated by the sieves (corresponding to 57 per cent. of the

crude, and to 40 per cent. of the decayed, wastes) the finer portions contained a further 28 per cent. and 31 per cent. respectively of sand and other insoluble substances, and one can only conclude that any beneficial action these refuses may exert must be due mainly to their favourable influence on the texture of heavy soils. With regard to the effect of the storage on the composition—it was evident that such substances as rags, bones, and even light iron canisters and tins had become, to a great extent, disintegrated by the processes of decay. This was well shown by the different amounts removed by the $\frac{3}{4}$-inch sieve, and by the character of the portions so removed. The storage, therefore, had undoubtedly resulted in the production of a more homogeneous mass, and in this respect was beneficial, but its effect on the chemical composition was negligible.

Another sample, similar in many respects to those described above, was sent by a farmer near Dartford. It could be obtained at a charge of 1s. 8d. per ton railway carriage, in addition to the cost of carting four miles.

Ref. No. 150.	Per cent.
Moisture	9·5
Organic Matter	42.56
Nitrogen	·93
Phosphoric Acid	·99
Equiv. to Tricalcic Phosphate	2.15
Potash	·74
Sand, etc.	33·40

Stones, cinders, pieces of wood, glass, etc., amounting in all to 10 per cent. of the original sample, were rejected before analysis. The organic matter in the portion analysed consisted largely of fragments of paper and cardboard—materials of no value as manure—and the inorganic residue was composed almost entirely of siliceous matter. Altogether the sample did not appear to be worth the cost of railway carriage and carting.

One other sample of this class of waste was examined. In this case, however, the material in question existed in the form of a surface deposit exposed by the operations of some gravel

works near the Thames, at Richmond, Surrey. It was supposed to be London refuse brought to the spot during a former tenancy, and the farmer who sent it wished to ascertain whether this deposit was worth the cost of carting on to the adjacent grass land. In appearance it resembled somewhat the decayed waste described on p. 238, and was examined in a similar manner. As was to be expected, decay had proceeded to a greater extent than in the case of the former sample, and no fragments of organic materials could be detected.

Mechanical separation.—The coarser portions were removed by the ¼ inch sieve—this retained small stones, cinders, etc., and some shells—amounting to 25 per cent. of the original sample.

Chemical analysis.

Ref. No. 372.	Per cent. on Fine Material.	Per cent. on Original Sample.
Moisture	15.40	—
Organic matter	14.26	10.71
Nitrogen	.39	.29
Phosphoric acid (total)	.45	.32
,, ,, (available)	.09	.06
Potash (total)	.09	.06
,, (available)	trace	trace
Calcium carbonate	7.27	5.45
Sand and insoluble matter	44.25	33.19

Here again, the substance appeared worthless as a fertilizer, the proportion of carbonate present being too small to be considered of value. Doubtless it might be applied with some benefit to heavy arable land, as a means of improving the tilth, but apart from this it certainly would not pay for carting.

Analyses of other waste substances examined are given in the following table. They included slaughter-house offals, factory wastes, and sewage sludges. Some were in good condition and would prove useful manures.

(See Table, p. 243).

No. 238 was sold as a Meat, Fish, Wool, and Blood Mixture. It was in very bad condition, being composed of lumps of flesh, large pieces of hide, unbroken bones, fragments of wood, etc., and possessed a particularly evil smell. It was also very moist, containing nearly 50 per cent. of water. Apart from the smell, there was little to recommend its use as manure, unless, indeed, it could be obtained for the cost of carting alone.

No. 392 was in much better condition, and would be worth about 20s. per ton. It contained a considerable quantity of common salt. The nitrogen was chiefly derived from fragments of hoof and horn, and would not therefore become rapidly available in the soil.

Sample No. 509, although described as slaughter-house offal, had evidently undergone a process of drying and grinding, and was similar in appearance to a good quality organic meal. It was well ground, and would form quite a valuable nitrogenous manure. The price was not quoted, but the nitrogen could be valued at the same rate as in Meat Meals, *i.e.*, about 12s. 6d. per unit, making the price per ton about £4 10s.

Two samples, Nos. 240 and 284, sent as "Bone and Hair Greaves," were composed of hair refuse mixed with unbroken hoofs, bones and large quantities of gypsum. The term "greaves" certainly ought not to be applied to mixtures of this nature, for true "greaves" consist of the dried and ground residues obtained in the manufacture of tallow or soap grease, and in many respects resemble Meat Guano. A good sample of Ground Greaves (No. 229) was analysed, and the figures are quoted in the table. It was greatly superior to these so-called "Bone and Hair Greaves."

A waste product from a paper factory—No. 252—sold as "Karo Cotton Meal and Bran" was offered at 35s. per ton, without a guarantee, the composition being given approximately as 0.4 per cent. ammonia, 5 per cent. phosphates, and

WASTE SUBSTANCES.

No.	Description.	Nitrogen.	Equiv. to Ammonia.	Phosphoric Acid.	Equiv. to Tricalcic Phosphate.	Potash.	Moisture + Organic Matter	Sand.
238	Slaughterhouse Offal	1.86	2.26	1.35	2.94	—	73.03	6.80
392	,, ,, ,, ..	3.25	3.94	1.14	2.27	1.51	—	18.55
509	,, ,, ,, ..	5.67	6.89	.96	2.10	.77	82.13	7.20
240	Bone and Hair Greaves ..	1.29	1.57	1.63	3.55	—	27.30	7.29
284	,, ,, ,, ..	4.60	5.58	1.26	2.73	—	54.74	4.80
229	Ground Greaves ..	4.14	5.03	5.04	10.99	—	66.07	8.56
252	Karo Cotton Meal ..	1.20	1.46	2.54	5.52	3.28	29.95	45.72
352	Sewage Sludge ..	1.93	2.35	.92	2.03	.26	59.06	21.64
514	Sludge Cake ..	.80	.97	.79	1.72	.35	73.28	6.06
518	Pressed Sewage ..	.50	.61	.32	.70	.29	65.92	4.85

4 per cent. potash. The sample, in fact, contained considerably more nitrogen than this, while the percentages of potash and phosphates were substantially as stated. Calcium sulphate was present in quantity, and there was also a little carbonate. The most noticeable feature of the material was its high content of fine sand—nearly 46 per cent. The price asked seemed beyond the actual money value.

Sewage sludges :—Three samples were sent in, of which one (No. 352) was quite different from any sludge we have previously examined. It was in the form of a fine black meal, and was said to be produced by a new process whereby ordinary sludge is subjected to the action of yeast. As a result of such treatment it was claimed that the nitrogenous compounds of the sludge were partly broken down, and consequently that ammonification proceeded rapidly in the soil.

It is fairly well known that ordinary sludge is not a very valuable manure, even when the bulk of the water has been expelled either by pressure or drying. It represents the insoluble portion only of sewage, contains but little fertilizing material, and that in no very available form. Further, most sludges contain quantities of oil or grease, and the pasty condition in which they are often obtained does not allow of their proper distribution in the soil. Where, however, they can be procured for the cost of cartage, or for little more, they often yield good results on light land, partly on account of the lime and partly because of the organic matter they contain. Numerous methods have been proposed for the treatment of these sludges, and plant has been erected at various places for the purpose of extracting and refining the grease. The residue is then obtained in a dry and friable condition and can be well incorporated with the soil.

In the case of the sample mentioned, the fermentation with yeast had resulted in the production of a substance in excellent physical condition, but, as far as could be ascertained from the analytical data, the availability of the manurial constituents had not otherwise been greatly increased. An attempt was made to estimate the proportion of nitrogen existing in the form of amides, and other easily decomposable compounds, by hydrolysis with dilute hydrochloric acid and subsequent

distillation with caustic soda and estimation of the ammonia produced. This yielded 0.4 per cent. only of Nitrogen, out of a total of 1.9 per cent. Extraction of the sludge with Dyer's 1 per cent. citric acid solution for twenty-four hours in a mechanical shaker gave a solution containing phosphates and potash equivalent to .35 per cent and .06 per cent. respectively of the original material. Apart, therefore, from the remarkably good mechanical condition, and the higher nitrogen content, there appeared to be little in this sample to place it much above the average dried sludge in value. It contained 6.82 per cent. of calcium carbonate, a figure considerably below that obtained for most of the sludges examined; the moisture content was also low, 23.06 per cent. The price of this material was not indicated.

Other samples, Nos. 514 and 518, were of the ordinary type of pressed sludge. No. 514 contained 55.5 per cent. of water and 14.9 per cent. of calcium carbonate; in No. 518 the percentages were 53 and 15.9 respectively. The former could be purchased by a potato grower near Gravesend at the rate of 1s. 9d. per ton, ex. wharf, in barge loads of seventy to eighty tons. The cost of carting and spreading brought the price up to about 3s. 6d. per ton on the land. At this price the sludge was well worth buying, if only for the chalk it contained. The land to which it was to be applied was of a light, sandy nature, very deficient in lime, and the dressing of sludge applied, twenty tons per acre, contained approximately three tons of chalk.

No information was received concerning Sample No. 518.

MIXED MANURES.

These do not require much detailed comment. Several were samples of home-mixed fertilizers, which, with one exception, were quite satisfactory, the mixing having been carefully carried out.

(See Table, p. 246.)

In No. 299, sulphate of ammonia had been mixed with sulphate of potash, superphosphate and *lime!* The results were rather disastrous. Half the nitrogen was given off by merely distilling with water, and the sample, of course, smelt

MIXED MANURES.

Ref. No.	Description	Nitrogen			Phosphates.			Potash.	Sand, etc.	Moisture and Organic Matter.
		as Nitrate.	as Ammonium Salts.	Organic	Water Sol.	Citric Sol.	Insol.			
229	Home-mixed ..	—	4.62	.04	—	18.10	6.13	12.51	.55	—
590	Bone Meal and Super ..	—	—	1.46	4.05	25.70	10.83	—	—	28.08
302	Calroo 473 ..	.89	.81	.11	2.93	5.4	1.10	7.12	18.85	—
320	Calroo XXX. ..	.60	1.13	.25	3.77	10.75	1.51	4.57	11.74	26.51
378	Mixed Nitrates ..	15.12	—	—	—	—	—	7.04	—	—
384*a*	Biphosphate ..	3.18	—	—	1.82	59.62	1.40	—	—	—
464	Phosphate Lime ..	.28	—	.36	—	2.99	4.79	—	17.32	7.25
601	Super. Organic Compound	—	—	1.22	—	12.96	2.41	.57	—	42.14
301	Potato Manure ..	.56	3.50	.18	13.87	—	1.45	10.37	4.66	—

strongly of ammonia. Considerable loss of nitrogen had probably occurred before the sample came to hand.

No. 590 was a mixture of bone meal and superphosphate in equal proportions. The resulting mixture was dry and friable, and is to be recommended for hops on the lighter soils.

Nos. 302 and 320 were mixtures of nitrate of soda, sulphate of ammonia, and sulphate of potash, with probably some basic superphosphate. A little vegetable *débris* was also present.

No. 378 contained nitrates of soda and potash, in the proportion of sixteen parts nitrate of potash to eighty-four parts nitrate of soda.

No. 384*a*. This was a new product, manufactured at the Notodden Nitrate Works, and was known as "Biphosphate." It was obtained by treating ground apatite with nitric acid, and was in the form of a fine, dry powder. Calculated from the nitrogen and citric soluble phosphate present, it contained 23.8 per cent. calcium nitrate, and 72 per cent. of dicalcium phosphate. We have not heard of any trials of this substance in practice, but it should prove a valuable manure if the price is not too high.

No. 464, "Phosphate Lime," contained 36.9 per cent. calcium carbonate and 5.8 per cent. quick lime, in addition to the constituents given in the table. A little nitrate was also present.

No. 601.—"Super-organic Compound." This sample was below its guarantee (1.45 per cent. nitrogen, 13 per cent. citric soluble phosphates, 3 per cent. insoluble phosphates, and .54 per cent. potash) in actual percentages, but came within the limits of error allowed by the Fertilizers and Feeding Stuffs Act. The mixture was moist and strongly acid. It was offered at £4 17s. 6d. per ton.

LIMES.

The importance of maintaining a sufficiency of lime in the soil seems to be becoming more generally recognised, for the number of samples analysed has exceeded those of former years and, moreover, we have answered numerous inquiries as to the use and application of this substance. Many of the soils in

Kent and Surrey are very deficient in lime, and the high cultivat'on which prevails in certain districts renders its application all the more imperative.

No.	Description.	Quick Lime.	Slaked Lime.	Calcium Carbonate.	Sand and Silica.
207	Ground Lime (grey)	31·75	—	9·85	8·98
295	,, ,, (white)	75·04	—	4·32	2·30
556	,, ,, ,,	—	67·72	12·14	4·07
460	Lump Lime (white)	—	45·64	14·61	4·87
510	Lime Ashes	12·95	—	12·04	50·65
271	Ground Chalk	—	—	92·45	3·66
441	Waste Lime	—	—	83·86	5·27
615	,, ,,	—	—	23·57	4·33
482	Tannery Lime	—	14·54	19·70	—

The quality of the samples examined has not been very satisfactory. Good white agricultural lime contains about 80 to 85 per cent. of lime, of which 5 to 6 per cent. may be in the form of undecomposed chalk. When finely ground, lime rapidly absorbs moisture and carbon dioxide from the atmosphere, and higher percentages of carbonate often occur in ground limes, unless the samples are quite fresh. A good sample, however, should not contain less than 75 per cent. of quick lime, or its equivalent in the air-slaked condition. Only one of the limes examined reached this standard.

No. 207 was a sample of lime made from mountain limestone, and for agricultural purposes was much inferior to limes made from the upper and lower chalk. The total calcium compounds dissolved by hydrochloric acid represented only 50.95 per cent. (calculated as Ca O). Magnesium compounds were present in quantity equivalent to 22.08 per cent. MgO and oxides of iron, alumina, etc., amounted to 14.24 per cent.

A sample of lime ashes—No. 510—contained but little of the useful calcium compounds, and seemed very dear at 10s.

per ton, considering that the price of good ground lime at the present time is from 13s. to 15s. per ton free on rail in bags. Lime ashes vary greatly in composition, and should always be bought on analysis. The variation in composition depends upon the quantity of coal ash or wood ash included, and is illustrated by the following analyses of other samples examined in this laboratory :—

Ref.	Total Lime (CaO)	Calcium Carbonate.	Sand, etc.
777	44.96	2.50	10.90
103*a*	63.54*	7.38	5.92

* Including 50.77 per cent present as quick lime.

The sample of ground chalk—No. 271—appeared to be identical with samples of the upper chalk previously examined. No chalk is absolutely pure, but the upper chalk is, in general, purer than the lower deposits. This sample was quite finely ground, 56 per cent. passing the 100 mesh sieve.

Other samples, Nos. 441, 482 and 615, were waste materials, containing varying quantities of lime, which would be useful at low prices. No. 441, a waste lime from a paper mill, consisted almost entirely of calcium carbonate. It was in a dry, powdery condition, no sulphites or other injurious substances were present, and the sample could be considered in every way equivalent to ground chalk.

No. 615, described somewhat vaguely by the purchaser as a "soft article," was possibly lime refuse from a glue factory. Its value was small, the bulk consisting of gypsum (41 per cent.) and water (30 per cent.) If obtainable for the cost of carting it might be useful on some heavy soils.

No. 482 was a Tannery waste, resembling the "lime grounds" mentioned in other reports. It represented the spent lime mixed with hair, obtained from the bottom of the vats. The composition by weight was, roughly, 33 per cent. of water, 64 per cent. lime refuse, and 3 per cent. hair. About 1 per cent. nitrogen was present.

FEEDING STUFFS.

Some seventy samples of cakes and meals were examined, a few of which deserve special mention and are discussed below. Several compound dairy cakes and meals, which were analysed in connection with the investigations carried out by the College on the cost of milk production, are described in that report. Of the samples sent in by farmers in the Counties, the majority were satisfactory, and presented no uncommon features. No Linseed Cakes were received.

COTTON CAKES.

(See Table, p. 251).

Generally speaking, the Decorticated Cotton Cakes examined have not proved quite satisfactory. The greater number showed evidence of admixture with ground hulls, and in our experience this practice is increasing. It has been stated that this is done with the object of rendering the cakes made from various sources more uniform in composition, but whether this is so or not, the introduction of such indigestible material is most undesirable. Samples Nos. 265 and 376 are typical examples, they contained noticeable quantities of husk, and the percentages of Crude Fibre present were correspondingly high. For the sake of comparison, the figures given by Crowther for the average composition of Decorticated Cotton Cake are included in the table. These figures are high when considered in the light of the standards recently adopted in America (see below), but they serve to indicate the composition of the best cakes.

Sample No. 163 was sold with a guarantee of 12 per cent. oil and 35 per cent. albuminoids, at £8 per ton. Although the actual percentage of oil fell considerably below 12, it came within the wide limits of error allowed under the Fertilizer and Feeding Stuffs Act; consequently the sample had to be considered up to its guarantee. At one time, Decorticated Cotton Cakes contained from 14 to 16 per cent. of oil, but now it is unusual to find cakes with even so much as 12 per cent. The average oil content is from 8 to 10 per cent.

It may be of interest here to give the standards for Decorticated Cotton Cakes adopted at the Annual Convention of the

DECORTICATED COTTON CAKES.

Ref.	Ether Extract.	Crude Protein.	Nitrogen.	Nitrogen Free Extract.	Fibre.	Mineral Matter.	Sand.	Moisture.
163	10.93	35.81	5.73	26.88	9.16	8.13	1.61	9.29
265	8.41	38.19	6.11	23.82	12.42	6.99	.04	10.17
376	6.99	37.01	5.92	25.27	14.15	5.95	.25	10.63
Average (Crowther)	9	41	6.56	26.20	8	8	—	8

Inter-State Cotton Seed Crushers' Association of America, held in June, 1912 :—

"Rule 10. Section 1.—Choice Cotton Seed Cake . . . shall contain not less than 8 per cent. of ammonia, or 49 per cent. of combined protein and fat.

"Section 2.—Prime Cotton Seed Cake . . . shall contain not less than $7\frac{1}{2}$ per cent. of ammonia, or 46 per cent. of combined protein and fat.

"Section 3.—Good Cotton Seed Cake . . . shall contain not less than 7 per cent. of ammonia, or 43 per cent. of combined protein and fat."

In Rule 12, Sections 1, 2, 3 and 4, the same standards are applied to Cotton Seed Meals. Any Cotton Seed product containing less than 36 per cent. of protein cannot be sold as Cotton Cake or Meal, but must be branded as adulterated, or as mixed with hulls.

The samples of Undecorticated Cotton Cakes analysed were all satisfactory and need no comment.

COMPOUND CAKES AND MEALS.

Compound Cakes and Feeding Meals still appear to be very popular, and large quantities are fed. The convenience of using one cake or meal in the place of a home-made mixture, which necessarily entails some trouble in its preparation, appeals to most farmers, but in many cases it is doubtful whether the practice is economically sound. This question cannot be discussed here, but we may reiterate the advice so frequently given—that compound feeding stuffs should be purchased only from firms of high standing, such firms being unlikely to run the risk of damaging their reputation by producing inferior cakes composed of mill sweepings, or other poor quality materials.

In the examination of Compound Cakes, chemical analysis alone is of little worth as a criterion of purity and feeding value. Useful indications may be found in the figures for crude fibre and sand—if these are excessive the cake may be regarded with suspicion—but more important than chemical analysis is the question whether or not the cake has been prepared from wholesome materials. On this point microscopical examination yields valuable evidence, and the

samples sent to the College are subjected to an additional investigation in this manner.

(See Table, p. 254)

The botanical composition of these feeding stuffs is given below.

With the exception of No. 504, the samples analysed this year were, on the whole, satisfactory. They were free from excess of fibre and sand, and in most cases weed seeds and other undesirable substances were either entirely absent, or present in very small quantity only.

No. 311. Undecorticated Cotton; Rice and Rice Husks; Locust Bean; Barley Meal. Treacle had been added and the whole pressed into small cakes.

No. 362. Undecorticated Cotton; Rice Meal; Lentils; Locust Bean; Wheat Starch. This cake contained some weed seeds, notably those of Black Bindweed and Black Medick; also a few grass seeds.

No. 411. Undecorticated Cotton; Soya Bean; Rice Meal; Locust Bean; some cereal Starch. A little black Mustard was also present.

No. 504. Cotton Seed; Rice Meal; Locust Bean. This sample had heated very badly—possibly owing to defective storage—and was full of fungus mycelium and spores. It was suspected of having caused considerable mortality amongst some Kent lambs to which it had been fed, but the results of our examination were not such as to confirm this view. The sample contained Undecorticated Cotton Seed, which is known to be an unsatisfactory food for young stock (*vide* Report 1912, p. 19), but the sheep in question were nearly one year old, the cake being fed in November and December. Whether or not the growth of moulds and other fungi in feeding cakes results in the formation of poisonous products is a point on which no definite evidence appears to be available. There can be little doubt that in practice much mouldy cake is fed, without any apparent injury resulting from its use. Be this as it may, in a feeding trial carried out for five days at the College with two Kent lambs, using half a pound per head per day of the sample in question, no ill effects whatsoever were observed. The sheep at first refused to take the cake, and would only do so after being kept for a day without

COMPOUND CAKES AND MEALS.

Ref.	Description.	Ether Extract.	Crude Protein.	Nitrogen.	Nitrogen free Extract.	Fibre.	Mineral Matter.	Sand.	Moisture.
311	Compound Dairy Cake ..	8.42	20.44	3.27	38.20	14.20	7.38	1.05	11.36
362	Compound Cake ..	8.94	20.88	3.34	37.12	15.55	6.24	1.36	11.27
411	,, ,, ..	5.91	19.29	3.09	42.96	10.74	7.61	1.47	13.49
504	,, ,, ..	4.07	22.81	3.65	38.23	14.08	7.92	1.25	12.89
605	Cod Liver Oil Condiment	13.03	10.24	1.70	49.46	6.63	5.40	—	15.24
400	Feeding Meal ..	9.65	21.88	3.50	36.71	15.16	6.79	1.28	9.81

food. We were unable to continue the trial for more than five days as the supply of cake was limited, but the period seemed sufficiently long to justify the conclusion that the cake alone was not toxic enough to cause so high a mortality as 50 per cent. amongst a flock of lambs.

No. 605. Cotton Seed ; Wheat ; Rice ; Locust Bean, and other spices.

This was a Cod Liver Oil Condiment, offered at 35s. per cwt. As in the case of another sample reported last year, the price was quite out of proportion to the feeding value, and the use of such expensive mixtures, even as condiments in small quantities only, would rapidly reduce any profit to the vanishing point.

It is not possible to draw up unit values for feeding stuffs in the same manner as is done for manures, and a precise estimate of the value of compound meals cannot be given on the basis of chemical analysis alone. A very good idea of the market value of this condiment may, however, be obtained from a consideration of the analysis, in conjunction with the botanical composition, as follows :—

Assuming the *whole* of the oil present to be Cod Liver Oil—(this, of course, was not actually the case, as the other materials present contained some oil)—the 13 per cent. represents about 33 gallons per ton. At 4s. 6d. per gallon, this is worth, approximately, £7 10s. With regard to the meals present, such a mixture could easily be made up from the best materials on the market at a price not exceeding £8 per ton. The total cost, then, of the chief ingredients (at retail prices) would certainly not exceed £16 per ton. This estimate does not include the cost of all the spices, nor the charges for mixing, bagging and carriage, but these would not nearly approach £19 per ton, the difference between £16 and the price asked. At the most generous valuation this condiment was not worth more than £19 per ton, and even then a more valuable food could be prepared at less cost by the farmer himself from such a mixture as the following :

2 cwt. Maize meal 1 cwt. Locust Bean meal ¾ cwt. Linseed Cake meal 4 lbs. Fenugreek 1 lb. Aniseed	With Cod Liver Oil 1½ gallons per cwt.

This mixture would not cost more than 17s. per cwt., and its composition would be approximately :—

Oil	15.6	per cent.
Albuminoids	11.5	,,
Carbohydrates	56.3	,,
Fibre	4.0	,,

Some trouble and labour is, of course, involved in the mixing of these materials—the meals must be well ground and the mixing thoroughly and carefully carried out—but, if such foods are deemed necessary, it is surely well worth while to prepare them in this manner, rather than to purchase the manufactured articles at extortionate prices.

The remaining sample quoted—No. 400—contained Cotton Meal, Rice Meal, and Locust Bean, and was clean and in good condition. It was described merely as a "Feeding Meal," and no price was mentioned.

MISCELLANEOUS MEALS.

(See Table p. 257.)

One sample of Fine Middlings, possessing a rather curious composition, was received. It differed from the average composition in that it contained rather less oil, and considerably less fibre and mineral matter—in fact, it approached whole meal in composition. Microscopical examination showed it to consist entirely of wheat particles, with numerous masses of fungus spores—smut and bunt. Whether or not these would render it obnoxious as a cattle food could not be definitely stated. Bunted wheat is not liked by stock, and has been known to cause poisoning.

The sample of Bran—No. 398—showed, on the whole, no abnormality in chemical composition. It appeared to contain no vegetable impurity, but was full of dead mites, and undoubtedly was an old sample.

No. 242 was a sample of Wheat Germ Meal. It was not an absolutely pure germ meal, as a certain amount of endosperm was mixed with it. The following analysis of Wheat Germ, quoted by Smetham (Roy. Lanc. Agric. Soc. Report,

MISCELLANEOUS MEALS.

Ref.	Description.	Ether Extract.	Crude Protein.	Nitrogen.	Nitrogen free Extract.	Fibre.	Mineral Matter.	Sand.	Moisture.
167	Fine Middlings ..	2.61	16.88	2.70	65.41	1.19	1.87	.20	12.04
398	Bran ..	2.47	15.94	2.55	54.48	11.48	4.58	.07	11.05
242	Wheat Germ ..	4.91	19.19	3.07	56.69	4.11	3.84	.04	11.26
403	Millers' Sweepings ..	1.52	10.00	1.60	68.41	1.74	6.60	2.38	11.73
516	Barley Meal ..	3.14	13.19	2.11	61.87	5.63	2.88	1.04	13.29

1909), shows, as would be expected, the presence of rather more oil and albuminoids, and rather less carbohydrates.

Ether Extract.	Crude Protein.	Nitrogen.	Nitrogen free Extract.	Fibre.	Mineral Matter.	Sand.	Moisture.
7.70	21.41	3.43	51.18	3.90	3.80	—	12.01

Wheat Germ does not appear to be used to any extent as a cattle food in this country—probably because large quantities are utilized in the manufacture of Hovis bread and similar products. It would certainly form an excellent food, but the price is high, a recent quotation being £7 per ton. It is sometimes fed to a limited extent when other wheat offals are dear.

Samples Nos. 403 and 516 were mill sweepings. The former consisted largely of wheat flour, together with barley and rice residues. It was distinctly gritty, and contained small pieces of coal and charcoal. For its class, however, it was of fair quality, and could be used, mixed with barley meal and pea meal, for pig feeding. For this purpose it would be worth about £3 10s. per ton.

No. 516 was a dirty sample of barley meal. Many weed seeds were present, notably black bindweed, convolvulus bindweed and dock, in addition to some wheat and oats. It was fairly free from sand, and would be quite useful at a low price.

OTHER FOODSTUFFS.

A few interesting samples were examined which are worth recording here. The first was a sample of condensed milk, taken from a consignment which had been condemned as unfit for human consumption. The farmer who forwarded this sample had an offer of a considerable quantity at a low price, subject to his giving an undertaking to use it only for the feeding of animals.

Ref. No. 365 :—

Butterfat	.62	per cent.
Protein	9.58	,,
Sugar	59.88	,,
Ash	2.30	,,
Total Solids	72.38	,,

The analysis showed the sample to be a condensed milk manufactured from sweetened skim milk. A certain amount of fermentation had occurred and an escape of gas was noticed on opening the tin. Bacteriological examination revealed the presence of some yeasts, and on distillation a trace of alcohol was obtained. No putrefactive changes became apparent, however, and there was no reason to consider that such fermentation as had occurred would render the milk dangerous to stock.

We have since heard that this milk has been fed to pigs and calves with excellent results. The pigs were fed three times a day with the following mixture :—

1 bushel bran,
5 gallons condensed milk,
40 gallons water.

The animals put on flesh rapidly, and the flesh produced was white and firm.

The calves were allowed to run with the cows for about a month, and were then fed with the diluted milk, with as much hay as they would take. They received at first 1½ lbs. of condensed milk per gallon of water, the quantity being gradually increased up to 3 or 4 lbs. Some scouring was noticed at the outset, but this soon ceased.

Another material suggested for use as cattle food proved to be much less valuable. It consisted of cyder "pomace" or "must"—the apple residue obtained from the cyder press. This pomace is used in parts of Somerset as a feeding stuff for pigs and cows, but in other cyder districts of England it is frequently thrown on to the land as manure, or sometimes into woods for the sake of the pips, which are eaten by

pheasants. In some of the French districts the pomace is salted and mixed with chopped straw, and it is said that three pounds of this mixture are equivalent to one pound of hay. The salted pomace is also converted into ensilage in straw-lined earth silos.

If the material is to be employed for feeding purposes, it must be utilized as soon as possible after leaving the press, otherwise acetic fermentation rapidly takes place, the pulp becoming acid and unusable. In the case of the sample received (No. 480) this acidity had developed to a considerable extent, and we could not recommend its use as a food.

(See Table, p. 261.)

The composition of another sample of Kent pomace, analysed at the College some years ago, is also included in the table.

The third analysis represents the average composition of six samples quoted by Lloyd in the *Journal* of the Bath and West Society, 1893, p. 105. A comparison of the figures shows that the sample recently sent to us contained considerably more moisture and much less carbohydrate and other extractive material. It appeared to contain only traces of sugars, the fermentation which had occurred since the pomace was taken from the press having converted the greater portion into alcohol, acetic acid and other products. Altogether, the sample did not appear at all promising, either for feeding direct or for conversion into ensilage.

Cæsalpinia Beans.

We were requested to examine the seeds of two species of Cæsalpinia, in respect of their suitability as cattle food.

The genus Cæsalpinia includes a number of species of leguminous plants indigenous to India and South America, certain of which produce seed pods containing a high percentage of tannin. One species (*C. corearia*) known as Divi-divi, has become already extensively employed in Europe as a tanning agent, while another (*C. digyna*), though long known to be of value for tanning purposes, has hitherto been used to a limited extent in India alone. As a result of investigations

CYDER POMACE.

Ref.	Description.	Ether Extract.	Crude Protein.	Nitrogen.	Nitrogen free Extract.	Fibre.	Mineral Matter.	Moisture.
480	Kentish Pomace	.37	.82	.13	6.79	3.14	.60	88.28
	,, ,,	—	1.31	.22	21.17	4.66	.86	72.00
	Average of Six Samples Somerset Pomace	1.08	1.27	.21	18.34	4.64	2.27	72.40
	Dried Somerset Pomace	6.15	9.45	1.51	40.92	25.02	8.80	9.66

carried out at the Imperial Institute* it was ascertained that the pod cases of the latter species were suitable for use by European tanners, and, in the more recent publication referred to, the possibility of their future importation into this country was indicated. Investigations were also made (*loc. cit.*) as to the possibility of utilizing the seeds of *C. digyna*, large quantities of which would become available if the pods were employed commercially in tanning.

The samples sent to us consisted of seeds of the species *C. digyna* and *C. tinctoria*. Those of the former were nearly spherical, about 1 cm. diameter, and possessed an extremely hard, thick shell; the seeds of *C. tinctoria*, on the other hand, were flattened, and furnished with a thin, shell-like seed coat. In the case of the latter the whole seeds were ground and analysed, while with *C. digyna*, the kernels were separated from the shells as completely as possible, and individual analyses made. The results are tabulated :—

(See Table, p. 263.)

With regard to *C. digyna*, the figures given above for the composition of shells, kernels, and whole seeds agree closely with those quoted in the *Imperial Institute Bulletin*, 1912. The samples therein described were submitted to commercial firms to determine their suitability for feeding purposes. It was reported that "the hard shells could not be removed without breaking the kernels, and that in order to utilize them it would be necessary to grind the whole seeds very finely so as to avoid the risk of danger from angular pieces of the shell. The finely ground seeds mixed with a cheap ground pulse might be used for feeding purposes in India, but they would not pay for export." It was further stated that, "Since the kernels contain only about 26 per cent. of oil, or about 13 per cent. expressed on the whole seed, it is very unlikely that the oil could be profitably extracted unless the seeds were obtainable at a very low price, especially as owing to the hard nature of the shell the residual 'cake' would be unsuitable for use as a cattle food."

From a consideration of the above report there appears to be little likelihood of *C. digyna* seeds being imported into this

* Technical Reports and Scientific Papers, 1903; *Bulletin*. Vol. X. No. 2, July, 1912.

CÆSALPINIA BEANS.

Ref.	Description.	Ether Extract.	Crude Protein.	Nitrogen.	Nitrogen free Extract.	Fibre.	Mineral Matter.	Sand.	Moisture.
	C. digyna shells (58 °/ₒ) ..	1.81	4.00	.64	59.19	20.26	3.30	.05	11.44
	,, kernels (42 °/ₒ)	26.97	16.01	2.56	44.06	1.88	3.70	.09	7.38
	,, whole seeds ..	12.37	9.04	1.45	52.84	12.54	3.46	.07	9.73
565	*C. tinctoria* whole seeds	6.28	18.32	2.93	49.19	11.14	3.24	.02	11.83

country as a food stuff. Should the pod cases ultimately become widely used as tanning materials, it is most probable that the seeds will be removed before exportation.

In the case of *C. tinctoria*, no information was available other than that furnished by the analysis ; the sample received was much too small to permit of an actual feeding trial being carried out. The absence of any distinct shell is a considerable advantage, and the beans might provide a useful feeding stuff, but the question of their profitable importation for such a purpose must necessarily depend upon many other factors.

WATERS.

As was stated in the Report for 1912, the characteristics of the water supplies of Kent and Surrey, and their relation to the various geological formations, have been frequently discussed in previous *Journals.* For information upon this subject reference should be made to the analytical reports appearing in Nos. 12, 14, 15, 16 and 17. The interpretation of water analysis has also been dealt with in Nos. 12 and 17.

With regard to the collection of samples for analysis, we should like to point out that unless particular care is taken to ensure the cleanliness of the vessel in which the sample is to be received, the value of the analysis will be entirely vitiated, and quite an erroneous opinion of the suitability of the water for drinking purposes may be formed. A Winchester quart glass-stoppered bottle (which will be forwarded from the College on request), should be rinsed out two or three times with the water in question, and then carefully filled. Stone ware jars and corked bottles are not satisfactory, and a rubber-stoppered Scrubbs' Ammonia bottle is the *worst possible* vessel to employ.

If the water is taken from a well, several gallons should be pumped before the sample is drawn ; if from a tap, some gallons should first be allowed to run to waste.

(See Table, p. 265.)

No. 196 was a sample drawn from a well 400 feet deep, through chalk. This well had been in disuse for seven years, and the occupier of the farm from which it was sent wished to know if it could safely be used for domestic purposes.

WATERS—Parts per 100,000.

Ref.	Locality.	Total Solids.	Ammonia free and Saline.	Albuminoid Ammonia.	Nitrogen as Nitrite.	Nitrogen as Nitrate.	Oxygen absorbed (4 hours).	Chlorine.	Hardness.
196	Wrotham, Kent ..	69.36	.014	.002	traces	.920	.038	11.05	38.85
282*a*	Ash, Canterbury ..	72.60	.0008	.014	traces	.500	.094	5.98	39.52
282*b*	Ash, Canterbury ..	110.50	.007	.021	slight trace	4.100	.201	11.65	34.28
297	Sittingbourne ..	129.20	.004	.009	nil	2.700	.046	14.10	68.80
449	Horley, Surrey ..	62.10	.036	.0008	slight trace	.001	.088	2.75	0.75
467	Epsom, Surrey ..	7.40	.0005	.004	nil	.040	.073	.55	4.00
501	Willesborough, Kent	118.0	.023	.025	heavy traces	3.700	.268	17.70	51.25
570	Plaxtol, Kent ..	46.60	.0005	.005	nil	.650	.062	1.70	35.50

The results of analysis were such as to cast some suspicion on the purity of the supply. A considerable amount of chlorine was present, and the total solids and hardness were high for chalk waters, which usually contain about thirty to forty parts of solids per 100,000, more than half being chalk. Free ammonia in this sample was also high, and traces of nitrites rendered it suspicious. It must be remembered, however, that in well waters the chlorine present varies greatly, and does not necessarily indicate sewage contamination. Even if originally derived from such a source, the organic matter which, in the earlier stages, accompanied the salt may have undergone complete destruction, and organically the water may be pure. Reduction of the nitrates, due to a variety of causes, also occurs in deep well water, and the presence of nitrites and ammonia in such waters does not therefore always indicate contamination. Nevertheless, in the case of this particular sample there was good ground for suspecting impurity, and, for a time at least, it would be desirable to boil and filter the water before use.

Samples 282 *a* and *b*. These were sent from a farm on the Thanet beds, near Ash, Canterbury. (*a*) was taken from a shallow well, twenty feet deep and only twenty-nine feet from a cattle yard, while *b* came from a well eighteen feet deep and eighteen feet from a cemented cesspool. The analytical results were strongly indicative of contamination in the case of sample *b*, while *a* was not above suspicion. The positions of these shallow wells (in a pervious formation) were certainly not such as to inspire confidence in the purity of the water, and although, in the absence of other supplies, *a* might be rendered fit for human consumption by boiling and filtering, constant care would have to be exercised to prevent further pollution by the entrance of surface water into the well, and the possibility of infiltration of washings from the yard in periods of wet weather could not easily be guarded against. The water from well *b* would always be subjected to a grave danger of contamination, and we could not recommend its use in any circumstances.

Apart from any question of organic purity, these samples exhibited the high solid content and great hardness which characterize so many of the Kent and Surrey supplies. It is

frequently stated that a high proportion of dissolved solids in a drinking water is inimical to health, and this may certainly be true in the case of such saline waters as some derived from the Weald clay, in which the total solids rise to 300 or 400 parts per 100,000. In other cases, however, it is impossible to fix any limit of purity and to say just what quantity of dissolved substance may be tolerated and what may not. The total amount of saline matter permissible in a water must depend in a great measure upon the nature of the dissolved salts; further, the human body possesses great adaptability, and persons accustomed to very hard waters may continue to take them with impunity. The danger lies, not so much in the actual quantity of the dissolved substances present, as in the ill-effects which often follow a sudden change from a comparatively soft to a very hard water. In this respect an analysis is likely to be of more use to a new-comer than to a native of any particular district. For the use of children and invalids, however, very hard waters must be considered undesirable, and for domestic purposes other than drinking they are decidedly objectionable.

Sample 297, derived from a well in the Thanet beds near Sittingbourne, was another very hard water, and on this account might prove unsuitable for drinking purposes, although it was apparently free from any organic contamination.

No. 449. This sample was taken from a tubed well, 213 feet deep, passing through Weald clay into Hastings' beds. This water was distinctly alkaline, and contained a high proportion of alkaline carbonates—equivalent to 47.52 parts of sodium carbonate per 100,000 (or 76.5 per cent. of the total solid content). Other waters derived from the Hastings Beds have been found to contain considerable quantities of sodium carbonate; so also have those obtained in certain districts from deep wells passing through London clay into chalk. Such waters, of course, are very soft, and are well adapted for domestic use, although they are said to be unsuited for boiler purposes, causing leakage at the rivets and corrosion of the taps. According to J. C. Thresh,* the presence of alkaline carbonates in no way renders a water

* "Water and Water Supplies," 1901, p. 124.

unfit for human consumption, even though they exist in quantities sufficient to exert a harmful effect upon plants if the water is used for garden purposes.

In addition to carbonates, this sample contained a relatively large amount of free ammonia, but, as previously stated, many deep well waters are known to contain much ammonia, although their purity cannot be questioned. From the information we were able to collect concerning this particular well, there was no reason to suspect organic contamination.

No. 467 was a sample of rain water collected from farm buildings and stored in a large cement tank sunk sixteen feet below the surface of the ground. Leakage of sewage matter into the tank was feared, but the analysis revealed no evidence of such impurity, and a careful inspection of the tank showed that no openings existed through which ground water might enter. The water might be consumed without danger, but periodical examination of the tank and thorough cleansing of all water courses would always be desirable.

No. 501. A very hard water with a high proportion of total solids, from a well sunk through Weald clay near Great Chart, Kent. Pollution was strongly indicated by the analysis, and we could not recommend the use of this water unless the cause of the contamination could be traced and steps taken effectively to remove it. The high chlorine content of this sample is characteristic of Wealden waters.

No. 570 was a sample taken from a spring rising in an arable field at a depth of three to four feet. The supply was tapped and conveyed in pipes by gravitation for about 120 yards to the homestead. This sample was sent from a farm near Plaxtol, Kent, and was probably derived from the Ragstone formation. The water was decidedly hard, but otherwise perfectly satisfactory. It was stated that the spring showed no signs of failing, even in the driest seasons.

No. 174. Determinations of chlorine and hardness were made in the case of two samples of water drawn from a tubed well near Deal. This well was close to the sea, and was driven sixty feet deep into chalk. The water was required for use in a laundry, but its great hardness and the large amount of salt present rendered it quite unsuitable for such a purpose.

	Chlorine.	Equiv. to Sodium Chloride.	Hardness.	
			Temporary.	Permanent.
Well, Low tide	316.25	518.65	32.13	105.00
,, High tide	301.25	494.05	31.57	99.50
Deal Town Supply	3.05	5.0	13.30	6.30

The figures represent parts per 100,000, and the hardness (determined by Hehner's Method) is calculated as parts of calcium carbonate.

Total hardness was also determined by Clark's method, using standard soap solution :—

	Total Hardness (by Soap Solution).	Total Hardness (by Hehner's Method).
Well, Low tide	165.10	137.13
,, High tide	159.50	131.07

The presence of so much salt caused considerable precipitation of the soap, and the figures for hardness obtained by this method are consequently much too high. The quantity of soap solution used, however, gave an indication of the amount of soap required just to produce a lather, and it was found that about four ounces of soap per gallon were necessary ! An addition of washing soda, at the rate of one ounce per gallon, would remove the real hardness and thus lessen the quantity of soap required, but it would not affect any alteration in the proportion of salt present, and for laundry use the water would remain most unsatisfactory.

MILK.

The samples examined for farmers in the Counties numbered 187, and of these 55, or 29.4 per cent., fell below the 3 per cent. limit for butter fat. Last year 18.5 per cent. of the milks

analysed were below the legal standard, and the average for the four preceding years was 26.1 per cent. Bad sampling may have been responsible for the poor quality of some of the samples received, but in the main it was probably due to the use of cows giving large quantities of rather poor milk. Much information relative to the quality of the milk produced by dairy herds in Kent and Surrey has been collected during the course of the investigations on the cost of milk production, and for further details reference should be made to the report on this work.

Complete analyses were made in the case of 33 samples, and determinations of butter fat only in the remaining 154. Improper sampling was clearly indicated in several cases, and four samples contained 12.3, 14.4, 14.75, and 19.6 per cent. of fat respectively. Practically in no instance was any information received concerning the samples examined.

The samples analysed included 42 taken under the Food and Drugs Act, and of these 34 were satisfactory. A few separated milks were also sent in, one of which, containing 1.35 per cent. of fat, was evidently obtained from a separator which required adjustment. A good separator should not leave more than .2 per cent. of fat in the separated milk. The fat in other samples did not exceed .5 per cent.—several contained less than .2 per cent.

Advice was asked in connection with an outbreak of "ropiness" in the milk produced on a Surrey dairy farm, which had occasioned serious financial loss to the farmer. The milk was retailed in a neighbouring town, and was taken direct from the farm to the town dairy, where it was immediately transferred to churns in the delivery carts and sent upon the rounds. An inspection of the premises directed suspicion to the wash-house in the yard of the dairy as the source of infection, and a thorough disinfection of this, together with all churns, cans and floats used on the rounds, immediately removed the trouble, and no further outbreak has since occurred. The origin of the infection could not be traced; no similar trouble had been experienced in other parts of the town, nor in the surrounding district, and no evidence was obtained which could cause the water supply to be regarded with any suspicion.

POISONS.

A number of cases of suspected poisoning have, as usual, been submitted to us for examination, but in no instance was any definite evidence obtained as to the presence of poison. In most cases more information was supplied concerning the feeding and symptoms of the animals affected than was received last year, but in several instances a more judicious selection of the organs forwarded for analysis was to be desired. Portions of brain, lungs and heart may be useful in certain respects, but they do not, as a rule, constitute the most promising material upon which to conduct a chemical analysis. Wherever possible, the *whole* stomach (with ingesta) should be sent, enclosed in a clean bottle or jar. Tins are not suitable receptacles.

One investigation may be mentioned here which, although not connected with any instance of actual poisoning, was concerned with conditions which were likely to result in poisoning. This was a case in which the water supply of a private house fell under suspicion on account of its depositing a grayish sediment on standing. A small quantity of this sediment was collected and sent to us for analysis, and a qualitative examination showed it to consist largely of zinc compounds—principally the carbonate with small quantities of iron and alumina, and a trace of lead. A sample of the water in question was not sent, but we were informed that it was very soft, containing not more than 8.5 parts of solids per 100,000, and that it was conducted from the main to the house through a supply pipe of galvanized iron, 100 yards long. It is well-known that soft waters readily attack the zinc coating of galvanized iron pipes, and in this particular case the unusual length of the supply pipe caused a large surface to be exposed to the solvent action of the water.

The house supply must therefore have been comparatively heavily charged with zinc, and until the whole of the coating had been dissolved off the pipe—which process might require a considerable time—the water could not be considered safe for domestic use. Unlike lead, zinc apparently does not act as a cumulative poison, and its effects on the system are not likely to be so deleterious as those produced by the former

metal. Nevertheless, several instances of poisoning by water containing zinc salts are on record, and the use of such water for drinking purposes may result in considerable injury to health.

FUNGICIDES AND INSECTICIDES.

No. 246. *Soft Soap.*—

Moisture	62.04 per cent.
Free Alkali	*nil.*
Carbonate	.03 per cent.
Lathering power	5.68

This was a rather inferior soap, the poor quality being largely due to the excess of moisture present—in a good sample this should not exceed 30 per cent. The lathering power expresses the number of pounds of soap required just to produce a lather with 100 gallons of the College water supply, which is of moderate hardness (about 20 parts per 100,000), and with high quality soaps this quantity has been found to vary from 3½ to 4 lbs. This amount is lost as far as spraying is concerned, since the curd produced is insoluble and does not answer the purpose for which the soap is used. From the figures obtained on analysis, it was calculated that 29 lbs. of the sample examined would be required to replace 19 lbs. of a first quality soap.

Flowers of Sulphur. Three samples were analysed.

Ref. No.	Moisture.	Ash.	Sulphur.	Fineness.
573*a*	.13	.01	99.86	97.44
573*b*	.12	.01	99.87	98.86
573*c*	.29	.08	99.63	74.06

All three samples contained small traces of arsenic. They were, however, in a high state of purity, and were very finely divided. Although sent as "Flowers" of sulphur, samples *a* and *b* more nearly resembled finely ground roll sulphur, which,

according to German authorities, is to be preferred to other forms for sulphuring purposes, as the structure of its particles enables them to adhere more closely to the leaves. Sample *c* was undoubtedly flowers of sulphur—its particles showed the characteristic rounded features of this form, moreover, it was to a great extent insoluble in carbon disulphide, while samples *a* and *b* were entirely soluble.

Nicotine and Tobacco Washes.—One sample of pure nicotine and some waste cloths from a tobacco factory were examined.

No. 329.—Nicotine :—

Sp. Gr.	1.015
Nicotine	95.76 per cent.

Although slightly weaker than the specified strength (98 to 100 per cent.), this sample could not be considered adulterated. The difference was too small to materially affect the quantity required to make 100 gallons of wash of the strength usually employed, about .075 per cent. In the case of this sample, 12.48 ozs. would be needed for every 100 gallons, as against 12.24 ozs. of 98 per cent. nicotine. In practice 12 ozs. is the quantity used.

No. 584. *Tobacco Cloths.*—These were press cloths from a factory, and consisted of sacking impregnated with tobacco juice.

Moisture	9.04 per cent.
Nicotine (Total)	2.60 ,,
Nicotine extracted by water ..	2.20 ,,

For the purposes of analysis the extraction with water was carried out at the rate of about three gallons per pound of cloth.

In view of the present high price of nicotine any waste product likely to serve as a means of supplying a cheap nicotine spray is worthy of attention. Unfortunately, the preparation of a wash from such materials is frequently attended with great disadvantages, which are exemplified in the present instance. If such tobacco cloths as those examined were obtainable at a low price—not exceeding 8s. per cwt.— a wash containing .08 per cent. of nicotine could be prepared by extracting them with water, at a cost of 3s. or less for the nicotine per 100 gallons. With pure nicotine the cost of making a wash of this strength amounts to nearly

10s. per 100 gallons. In such a case the material would be well worth a trial, but the practical difficulties connected with its use in large hop gardens or fruit plantations would be considerable. Whenever spraying becomes necessary to prevent or keep down an attack, it is usually essential that the whole area affected should be treated in the shortest possible time, otherwise much damage may occur. This necessitates the preparation of large quantities of wash in the most rapid manner, and for this reason *concentrated* solutions are needed which can be kept in stock and easily diluted to the requisite strength. The great disadvantage attending the use of such materials as these tobacco cloths is that in the majority of cases a concentrated extract cannot be prepared. The weight of the cloths required to yield 100 gallons of wash was found, by calculation from the percentage of nicotine extracted, to be 40 lbs., which quantity, when soaked in water, would occupy considerable bulk, and would retain a large amount of liquid when removed from the solution. Consequently the stronger the extract the greater would be the amount of nicotine left in the cloths, unless a powerful press were employed to remove the absorbed liquid. As no such press would be available in most instances, it follows that to ensure the most complete extraction the largest possible quantity of water must be used—*i.e.*, the full quantity of water needed for the wash. The extraction, moreover, must be allowed to proceed for at least a day, so that in the case of large gardens it would be necessary to provide tank accommodation capable of receiving the whole volume of wash that could be applied in one day ; and if the work has to continue for several days without intermission the tanks would have to be duplicated. This introduces a serious difficulty, for such tank accommodation could not be provided in most gardens and plantations. The use of these cloths and similar tobacco wastes must therefore be limited to the spraying of small plots, or to special cases where the work can be done slowly.

Another point of importance in connection with the sample examined was that the actual strength of the solution prepared from it would be a matter of uncertainty, as it was improbable that all the sacking would contain the same percentage of nicotine.

THE EFFECT OF FERROUS SULPHATE ON THE QUALITY AND QUANTITY OF POTATOES.

By D. R. Edwardes-Ker, B.A., B.Sc.

In considering those constituents of the soil which are removed in largest amounts by growing crops, and which may therefore become deficient in the soil as a result of continued cropping, it is customary to postulate only three with regard to which there is any need to make good such loss by the addition of fertilizers containing them.

These three constituents, nitrogen, potash, and phosphoric acid, are therefore the only substances which in general farming practice are added to the soil, and fertilizers are therefore classed as complete, nitrogenous, potassic and phosphatic according to whether they contain all or one of the above constituents in a form available as plant food. It is true that other materials—lime, chalk, gypsum, etc.—are, in many cases, applied to the land, but their function must be regarded as quite distinct from that of serving as direct plant foods, or of making good any deficiencies that may exist, inasmuch as they are always indirect in their action, and serve various purposes, such as rendering the other materials of the soil more available for the nutrition of plants, correcting acidity, which always delays beneficial bacterial action, coagulating the finer particles of clay and thus lightening heavy lands, and in general assisting in various other processes of like nature.

In the last few years, however, attention has been directed towards the action of many other chemical compounds, generally different metallic salts, the very existence of which in ordinary soil is often entirely overlooked, which, when added

in relatively minute quantities show a marked effect upon the yield or quality of crops. In larger amounts, still, however, small in comparison with the quantities of the usual fertilizers applied, a toxic or poisoning action is often noticed, and indeed it seems as if these substances, to which the name of "catalytic" fertilizers is given, are only helpful in their action when they are submitted in sufficiently small doses to the plant. Indeed, it is doubtful if in many cases the action is on the plant at all, and the results of experiments with these catalytic fertilizers may often be the more easily explained by hypotheses connecting their action with the different bacteria now known to be present in all soils.

Flowers of sulphur, compounds of manganese, iron, boron, copper, zinc, lead, arsenic, and aluminium, are examples of such catalytic fertilizers, and there are already extant a multitude of original papers and reports of pot and field experiments, showing that in many cases a very real and marked increase in various crops has followed directly on, and must therefore be attributed to, their influence.

Recent work on the subject includes that on Manganese, by Ray and Pradier,[1] Bertrand,[2] and more recently Boullanger,[3] who found marked increases in the yields of such different crops as apricots, oats and beet, and potatoes respectively, on treatment with various manganese salts.

Flowers of sulphur have been found in the case of certain crops to give largely increased yields by Demolon,[4] Bernhard,[5] and Boullanger,[6] and the use of the substance has received an unusual amount of attention at the hands of investigators.

The published results of experiments with ferrous sulphate are not so numerous as those dealing with other catalytic fertilizers, but some of the more important papers on the subject are those cited below, by Griffiths, Bolley, McCallum, Boullanger and others.

In this field of research, however, there has been a certain want of concordance between the results of different investigators, and even the same experimenter has failed in certain cases to repeat his results, which facts can only be explained by the assumption that the action of catalytic fertilizers depends upon certain factors at present not entirely understood.

The present paper deals with certain field experiments carried out with one of these catalytic fertilizers, namely, ferrous sulphate, or protosulphate of iron, and, moreover, the effect of this substance on one specific crop, the potato, is alone investigated. The reason that led the author to confine the work to within these comparatively narrow limits arose from a consideration of the different varieties of potatoes grown in various parts of the United Kingdom, and the way in which their value depends largely upon their " quality," especially as regards the immunity of the tubers from turning dark in colour on boiling. The potatoes that show this immunity to the highest degree are those grown upon certain soils in the neighbourhood of Dunbar, and that it is the soil that is largely the determining factor is evident from the fact that seed of the same varieties as grown at Dunbar do not, when grown elsewhere, produce tubers showing this desirable property to such a marked extent.

One of the main characteristics of the Dunbar potato soils is immediately evident to the eye, their colour being decidedly of a rich, reddish tint. This coloration is due to the nature of the underlying stratum, a variety of the old red sandstone, which is found to be high in its iron content, and which, in the process of weathering, has given rise to a soil proper which is also rich in this element. It is true that the red colour alone cannot be entirely taken as an indication of a high percentage of iron, and in fact other soils are known which contain a greater proportion and nevertheless possess a colour of less marked intensity. Indeed, it is patent that the postulation of a theory that a good potato soil could be even approximately gauged by the redness of its colour would be absurd, for that combination of qualities which fits a soil specially for the production of one particular crop of high quality is much too complex and subtle to be even guessed at in a large majority of cases. In the same way, actual percentage of iron in a soil and suitability for potato culture probably have little connection with one another, and even if th reputation borne by the Dunbar soils does depend upon the presence of iron in these soils, the dependence probably has to do more with the actual forms in which the iron exists, than with its amount. The same conclusion is arrived at

by arguing from another standpoint. The need of the potato for iron is not above the average for plants in general, and as a matter of fact, the complete potato plant (tubers and haulm) seldom contains more than .06 per cent. of this element; taking this in conjunction with the fact that the average iron content of soils is seldom less than 2 per cent. (20 tons per acre in the top nine inches), and this largely in a readily available form, it is evident that there is never the slightest danger of any plant requiring more iron than it can readily obtain with little difficulty, consequently the usė of iron manures (taken in the ordinary sense of the term as material supplying plant foods) would be an absurdity.

It is not impossible, however, that some specific iron compounds may exert a certain action, beneficial or otherwise, upon plants, not, it is true, in the ordinary manurial sense, but rather in the direction of a stimulating or toxic action, which may help or prevent, as the case may be, the ordinary vital processes of the plant, and so lead to the production of higher or lower quality and quantity, in the same way that minute doses of poisonous compounds, strychnine, arsenic, etc., have a beneficial effect in many cases on the human system.

Iron is undoubtedly intimately connected with the formation of chlorophyll, the green colouring matter of plants, which is just as vital to their well-being as is the presence of the red blood corpuscles in the blood of animals and human beings. Chlorophyll is in fact the agent whereby plants can, so to speak, feed themselves, and it is by the agency of this substance that the large proportion of dry matter, consisting of cellulose, starch, sugar, gums and proteins can be elaborated and built up from the carbon dioxide of the atmosphere, in conjunction, in the two latter cases, with the relatively small proportions of phosphorus, potash, lime, etc., obtained from the soil.

In spite of the fact, therefore, that iron does not actually enter into the composition of the substances composing chlorophyll, nevertheless, it is intimately connected with their production, as shown by the fact that in the entire absence of iron, the green colour of plants is not developed, while in cases of chlorosis, an affection due to lack of chlorophyll in the leaves

of plants, an external application to those organs of a dilute solution of ferric chloride will remedy the trouble and lead to the speedy return of a normal healthy colour.

That ferrous sulphate has a certain stimulating effect on the growth of plants was probably first noticed as a result of the use of a solution of that substance as a spraying material for the destruction of certain weeds, dandelions, etc.; when it was remarked that an improvement in the crop followed, in addition to the destruction of weeds.

Griffiths,[7] in the eighties, published results of field experiments he had carried out on the use of ferrous sulphate as a top dressing for many of the common crops, used at the rate of half a hundredweight per acre. The figures given are remarkable in that a largely increased yield was obtained in almost every case, with such varied crops as beans, turnips, meadow hay, mangolds and potatoes. It was found that the different parts of the plants, roots, tubers, leaves, etc., were equally stimulated, and an analysis of the ash constituents in the different cases showed that treatment with ferrous sulphate brought about an increase in the percentage of iron, and practically no change in the other constituents, excepting in the case of potash, which showed a decrease as the percentage of iron increased. This latter observation led Griffiths to make the suggestion that iron can replace potash to a certain extent in the working of the vital processes of plants.

In the case of potatoes, Griffiths reports that by the use of half a hundredweight of ferrous sulphate, he obtained an increase of two tons of tubers to the acre, a proportionate increase in the haulm, while an analysis of the tubers showed higher values for albuminoids and soluble carbohydrates.

The same author, in his "Treatise on Manures,"[8] quotes results similar to his own obtained by various other investigators, and concludes his remarks by stating that:

(i.) In the case of those crops which develop a large amount of chlorophyll, a soluble iron manure is most beneficial.

(ii.) An iron manure greatly increases the percentage of soluble carbohydrates and albuminoids in various crops, and thus enhances their value as feeding stuffs.

(iii.) The sulphur of the ferrous sulphate acts as a food for the protoplasm of vegetable cells, and the iron for the chlorophyll.

(iv.) Iron sulphate increases the percentage of ferric oxide and phosphoric acid in the ashes, showing that the increased yield is due partly to the direct manurial value of ferrous sulphate.

(v.) Iron sulphate in excess is a plant poison, the antidote, if an excess has been added, being the application of lime.

(vi.) Soluble iron compounds are necessary for the formation of chlorophyll, therefore if a soil is deficient in soluble iron, although it may contain an abundance of insoluble iron compounds, farm crops and plants generally must suffer.

(vii.) Iron sulphate is not a stimulant, but a direct, as well as an indirect, plant food.

Considering the importance of these results if they had been confirmed under other conditions and on other soils, the paucity of publications on the subject since the appearance of Griffiths' papers is at least remarkable. This may be due to the reason that other experimenters working along similar lines have obtained negative results, which they have refrained from publishing. The fact remains, however, that it is only quite recently that other reports on the use of ferrous sulphate as a fertilizer have appeared.

Bolley,[8] in 1908, mentions that he employed ferrous sulphate as a spray on lawns, and that the growth of the grass was stimulated.

McCallum[9] reports that he found the use of ferrous sulphate as a spray on tomatoes to increase the fruitfulness to a slight extent.

Masoni,[10] in 1911, found that the use of ferrous sulphate on corn led to an increase in dry matter; while Rodin,[11] in the same year, states that ferrous sulphate killed the mustard present in a crop of oats, and at the same time increased the yield of grain.

The most recent report on the subject is that published by Boullanger,[12] who has kindly placed his results at the writer's disposal. Experimenting with ferrous sulphate as well as with other similar "catalytic" fertilizers, Boullanger found that the application of the substance to pot cultures of

celery, lettuce, onions and potatoes was undoubtedly followed by a beneficial action.

In order to investigate the effect of ferrous sulphate on potatoes, and to determine whether the composition of the soil, especially as regards to its content of chalk or lime (see above, p. 27 v.) had any influence on the results obtained, field experiments were carried out during 1912.

The investigations were performed in two series: (1) with small garden plots of 1 rod ($\frac{1}{160}$ acre) to determine the effect of increasing quantities of ferrous sulphate; (2) with larger field plots of 4 rods ($\frac{1}{40}$ acre) to determine the effect of $\frac{1}{2}$-cwt. ferrous sulphate to the acre, under conditions involving a smaller experimental error.

Series 1. (Garden Plots.)

Ten square plots of one rod each in area were measured out in the College gardens on a piece of land which had received similar treatment with regard to manuring and cropping for at least four years previously.

The disposition of the different plots is shown in Fig. 1, page 282.

The plots were dug over at the end of October, 1911, and again dug and dressed with short farmyard manure at the rate of ten tons to the acre at the end of the following March.

On April 3rd, the seed, Scottish Triumph, was planted, with fourteen inches between the tubers and thirty-one inches between the different rows.

The following dressing of artificials was given with the drills.

$\left.\begin{array}{l}\text{1}\tfrac{1}{2}\text{-cwt. sulphate of ammonia}\\ \text{1-cwt. sulphate of potash}\\ \text{3-cwt. superphosphate}\end{array}\right\}$ per acre.

On May 22nd, when the young plants were three to four inches high, ferrous sulphate was applied in solution in water to the various plots at the following rates per acre:

Plot 1.—Nil.	Plot 6.—$\frac{1}{4}$-cwt.
Plot 2.—1-cwt.	Plot 7.—$\frac{1}{2}$-cwt.
Plot 3.—$\frac{1}{8}$-cwt.	Plot 8.—$\frac{1}{2}$-cwt.
Plot 4.—$\frac{1}{8}$-cwt.	Plot 9.—$\frac{3}{4}$-cwt.
Plot 5.—$\frac{1}{4}$-cwt.	Plot 10.—Nil.

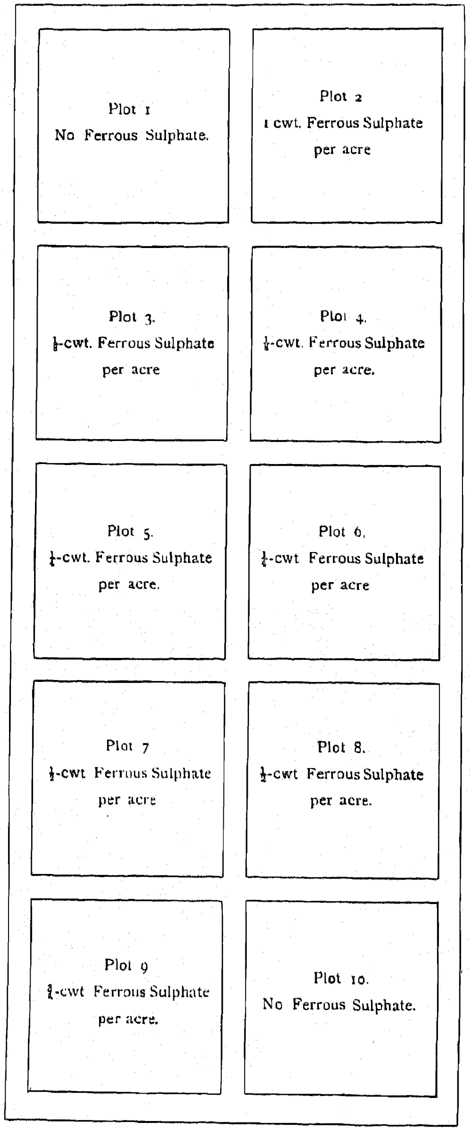


Figure I. GARDEN PLOTS.
Each plot = 5½ yds. × 5½ yds. = 1 square pole.

At the time of application of the ferrous sulphate, no difference between the various plots was noticeable. Later, however, all the right-hand plots (2, 4, 6, 8 and 10) were found to be outpacing their neighbours, at least with regard to leaf production, and this difference was attributed to the fact that the right hand strip of land had been under Brussels sprouts five years previously, and had thus received an especially heavy dressing of dung. As the different plots receiving similar quantities of ferrous sulphate were alternately within and without this strip, the effect of this inequality was, in all cases but two (*viz.*, plots 2 and 9,) neutralized by averaging the results, although it will be noticeable from the results given below that a larger weight of tubers was in all cases obtained from the right-hand plots.

A frost on May 25th did a certain amount of damage to all the plots, although the number of plants affected did not vary largely as regards the different plots.

The potatoes were dug on October 14th, when it was found that a number of the tubers were rotted and diseased, presumably as a result of the wet summer, which was found to affect considerably the potato crop in the district. The sound and rotted tubers were weighed separately, in order to detect, as a matter of additional interest, whether there was any difference with regard to immunity to disease that could be attributed to the ferrous sulphate.

The results obtained are given below, Fig. II., in tabular form.

FIG. II.

It will be seen that in every case the yields on the right hand plots surpassed those on the left hand plots, this being attributed, as mentioned above, to the difference in treatment of the land five years previous to the experiments.

On averaging up the yields, the following numbers are obtained. (See Table, p. 284.)

FIG. III.

Owing to the fact that the plots treated with ferrous sulphate at the rate of $\frac{3}{4}$-cwt. and 1 cwt. per acre respectively were not in duplicate, the figures in brackets in the table should not be taken into account, owing to the great

FIGURE II.—TABULATED RESULTS OF GARDEN EXPERIMENTS.

Number of Plot.	Right or Left Strip.	Ferrous Sulphate at rate per acre.	Weight of Haulm.	Weight of Sound Tubers.	Weight of Diseased Tubers.	Total Weight of Tubers.
I.	Left	Nil.	6 lbs.	98 lbs.	20 lbs.	118 lbs.
II.	Right	1 cwt.	10 lbs.	132 lbs.	43 lbs.	175 lbs.
III.	Left	$\frac{1}{8}$ cwt.	7 lbs.	92 lbs.	32 lbs.	124 lbs.
IV.	Right	$\frac{1}{8}$ cwt.	11 lbs.	134 lbs.	40 lbs.	174 lbs.
V.	Left	$\frac{1}{4}$ cwt.	10 lbs.	115 lbs.	29 lbs.	144 lbs.
VI.	Right	$\frac{1}{4}$ cwt.	11$\frac{1}{2}$ lbs.	154 lbs.	55 lbs.	209 lbs.
VIII.	Left	$\frac{1}{2}$ cwt.	9 lbs.	99 lbs.	30 lbs.	129 lbs.
VIII.	Right	$\frac{1}{2}$ cwt.	10 lbs.	130 lbs.	40 lbs.	170 lbs.
IX	Left	$\frac{3}{4}$ cwt	8 lbs	95 lbs	25 lbs.	120 lbs.
X.	Right	Nil	13 lbs.	126 lbs.	50 lbs.	176 lbs.

FIG. III.

	Plots treated with Ferrous Sulphate at the following rates per acre.					
	Nil. 2 Plots.	$\frac{1}{8}$ cwt. 2 Plots.	$\frac{1}{4}$ cwt. 2 Plots.	$\frac{1}{2}$ cwt. 2 Plots.	$\frac{3}{4}$ cwt. 1 Plot.	1 cwt. 1 Plot.
Average weight of haulm (lbs.) ..	9·5	9·0	10·7	9·5	(8)	(10)
Average weight of sound tubers (lbs).	112	113	134½	114½	(95)	(132)
Average weight of diseased tubers (lbs.)	35	36	42	35	(21)	(24·5)
Average weight of total tubers (lbs.)	147	149	176½	149½	(120)	(175)
Percentage of total tubers diseased (lbs.)	23·8	24·1	23·8	23·4	21	24·5

difference between the right hand and left hand plots. The percentage of diseased tubers may, however, be given equal prominence in the case of the two plots mentioned, and for this reason the last two figures are not bracketed.

It will be noticed from the above table that in the case of those plots that were in duplicate, there is a most marked agreement between the figures obtained for weight of haulm, sound tubers, diseased tubers and total tubers respectively, excepting in the case of the $\frac{1}{4}$-cwt. plots, which give values for tubers different to those applying to the other three. The cause for this discrepancy is unknown, and as it can hardly be assigned to the beneficial effect of ferrous sulphate in this quantity only ($\frac{1}{4}$-cwt.), it must be considered as being due possibly to some difference in the previous history of that part of the area experimented upon, such as the existence there of a manure heap on some earlier occasion.

The percentage of total tubers diseased is also seen to be remarkably constant.

It must be concluded, therefore, from a consideration of the figures given for the duplicate plots, that the application of ferrous sulphate up to $\frac{1}{2}$-cwt. per acre has no effect whatever either on the yield of tubers or of haulm, while by a comparison of plots 1, 3 and 9 (all right hand plots), it seems as if the application of $\frac{3}{4}$-cwt. ferrous sulphate per acre is also entirely inoperative (see Fig. IV.).

FIG. IV.

Comparison of plots 1, 3 *and* 9, *showing there to be no effect up to* $\frac{3}{4}$*-cwt. ferrous sulphate.*

Plot.	Ferrous Sulphate per acre.	Weight of Haulm.	Total Weight of Tubers.
I.	Nil.	6 lbs.	118 lbs.
III.	$\frac{1}{8}$ cwt.	7 lbs.	124 lbs.
IX.	$\frac{3}{4}$ cwt.	8 lbs.	120 lbs.

Referring again to Fig. III., it will be seen from the last horizontal row of figures, representing the percentage of total tubers diseased, that there is no immunity to such disease noticeable, up to the maximum amount (1-cwt. per acre) of ferrous sulphate employed.

The above series of experiments cannot, consequently, on the facts and figures given, be considered as in any way in agreement with Griffiths' results as published in his papers quoted above. Similarly, if experiments under gardening conditions can be compared with pot cultures, Boullanger's observations as to the beneficial effect of ferrous sulphate have not been repeated.

This want of agreement is not dealt with at this stage, as a possible cause for the discrepancy is discussed below, after the results obtained from the field experiments are given.

SERIES II. (FIELD PLOTS.)

The experiments in this series were on a larger scale than those quoted above, being carried out under ordinary farming conditions on square plots of land of $\frac{1}{40}$ acre each, this area being the one recommended by Mercer and Hall,[13] who found that the reduction in the experimental error is relatively small, when plots exceed in area this figure. The potatoes took their place in the usual rotation practised on that part of the College farm where the plots were situate, the previous crop having been oats. When the oats were harvested, the land was given 20 tons of dung to the acre, the manure being ploughed

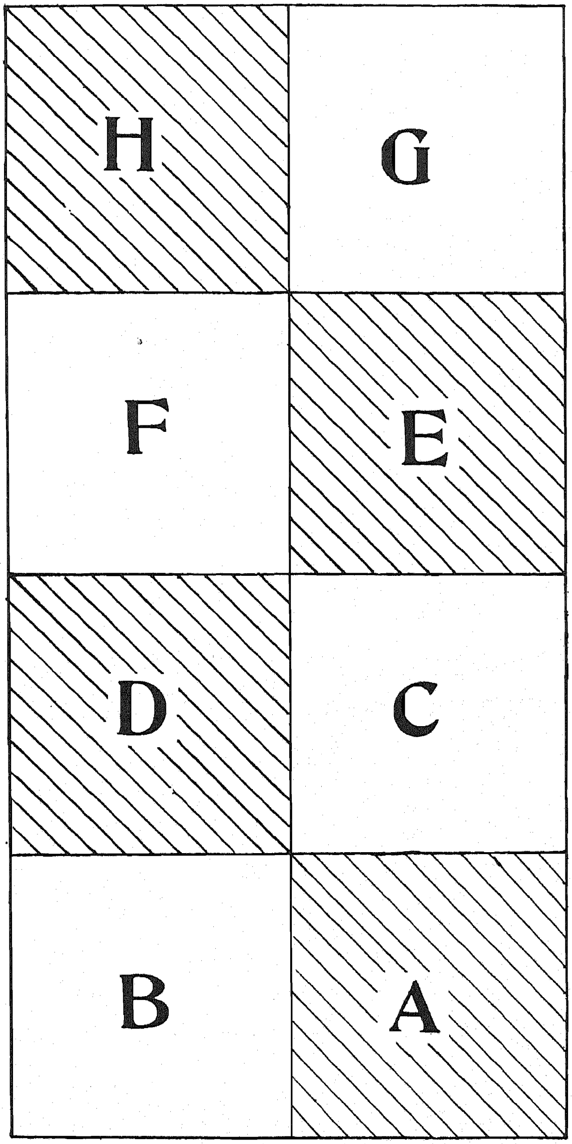


Figure V. FIELD PLOTS.
Lined plots = treated with ferrous sulphate.
Unlined plots = untreated plots. Area of each plot = $\frac{1}{40}$ acre.

in. After the spring ploughing, the following dressing was sown in the furrows with the seed :

$$\left.\begin{array}{l}\text{4-cwt. meat and bone meal}\\ \text{1-cwt. sulphate of ammonia}\\ \text{1-cwt. superphosphate}\\ \text{1}\tfrac{1}{4}\text{-cwt. sulphate of potash}\end{array}\right\}\text{ per acre,}$$

the ridges being then split back.

It was not until after this treatment, but before the young plants showed, that the plots were measured out in the middle, more or less, of that part of the field planted with the variety of potatoes experimented on, namely Dalhousie (Scotch seed).

This series of experiments was not carried out along the same lines as Series I., as it was desired to test more completely whether or not plots treated with that amount of ferrous sulphate found by Griffiths to be most effective gave any different results to those obtained on neighbouring plots not so treated. The plots were therefore so arranged as to obviate to as great an extent as possible any variations in composition of soil, or other factors that might have an effect upon the results obtained.

FIG. V.

As will be seen on reference to Fig. V., four plots were treated with ferrous sulphate and four were left untreated, the disposition of the plots being such that treated and untreated were arranged alternately in two directions, the effect of such a disposal being to minimise all errors due to soil variations, etc.

On June 20th, when the young plants were three to four inches high on the average, the ferrous sulphate was applied to A, D, E and H at the rate of 1.4 lbs. per plot of $\frac{1}{40}$ acre ($=\frac{1}{2}$-cwt. per acre). To aid in even distribution, the crystals were coarsely crushed, well mixed with about twice their bulk of sand, and the material so obtained broadcasted by hand. As the weather showed no signs of rain, it was thought advisable to immediately water in the ferrous sulphate, in order to avoid it lying on the surface and thus becoming rapidly oxidized. The untreated plots, B, C, F and G, were also watered at the same time.

Except for this addition of ferrous sulphate, the experimental part of the field underwent the same treatment as the rest, with regard to ridging, hoeing, etc., until the potatoes were dug on October 10th.

The total weight of tubers in each plot was then determined, the total weight of haulm from each plot obtained by calculating that for the weight of the haulm of the two middle rows in each case.

The experimental weights were as follows :

FIG. VI.

WEIGHTS OF TUBERS AND HAULM ON FIELD PLOTS.

Plot.	Treated or Untreated with Ferrous Sulphate.	Weight Haulm.	Weight of Tubers.
A	Treated	$94\frac{1}{2}$ lbs.	435 lbs.
B	Untreated	$94\frac{1}{2}$ lbs.	410 lbs.
C	,,	91 lbs.	440 lbs.
D	Treated	70 lbs.	383 lbs.
E	,,	$115\frac{1}{2}$ lbs.	449 lbs.
F	Untreated	$75\frac{1}{2}$ lbs.	453 lbs.
G	,,	$115\frac{1}{2}$ lbs.	455 lbs.
H	Treated	$75\frac{1}{4}$ lbs.	473 lbs.

TOTAL AVERAGE WEIGHTS OF TUBERS AND HAULM ON FIELD PLOTS.

	Total Weight Haulm	Average Weight Haulm.	Total Weight Tubers.	Average Weight Tubers.
Treated plots	$355\frac{1}{4}$ lbs.	$88\frac{3}{4}$ lbs.	1740 lbs.	435 lbs.
Untreated plots	$376\frac{1}{2}$ pls.	$94\frac{1}{8}$ lbs.	1758 lbs.	$439\frac{1}{2}$ lbs.

An examination of the figures given shows that there is no effect on the yield either of tubers or of haulm as a result of the treatment with ferrous sulphate. The total weight of tubers

on the treated plots shows as close an agreement with the total weight on the untreated plots as can be expected with field experiments, while the difference in the case of the haulm is well within experimental error.

It must be concluded, therefore, that, under the conditions attaching to the two series of experiments described above, the treatment of growing potato plants with ferrous sulphate in quantity equal to ½-cwt. per acre results in no increase whatsoever in the yield.

The conditions affecting the results of experiments on a practical scale are, however, so varied in the case of different experimenters, that a want of concordance between such results should lead one rather to consider carefully to what factors such a disagreement may be due, than to hastily conclude that the previous work is unsatisfactory. The work of Griffiths quoted above is fairly definite in pointing to the fact that ferrous sulphate has a very potent effect in some cases as a stimulant of plant life. Boullanger's most recent experiments seem to confirm this, and it may be advisable to quote herewith the figures obtained by this latter investigator, in so far as they refer to the effect of ferrous sulphate on potatoes.

The potatoes were grown in pots, which had previously been filled with a " rich " soil, and watered immediately before sowing with a solution of ferrous sulphate in the case of half the number of pots, the others being left untreated. The ferrous sulphate so added was at the rate of 1 gram of the salt per 30 kilograms of the soil, which is equivalent to about 82 lbs., or ⅔-cwt., per acre.

The total average weights of tubers and haulm per pot was found to be as follows :—

Untreated pots	207 grams.
Treated pots	273 grams.

While it is impossible to compare these yields with the figures given above for the experimental plots, it is nevertheless evident that the ferrous sulphate has produced an increase of over 30 per cent.

In the light of these results it remains, therefore, to attempt a detection of the factor causing the variation between the results obtained at Wye and those of Griffiths and Boullanger.

In the opinion of the writer, this difference is due to variations in the types of soil upon which the several investigations were carried out.

The soil at Wye, upon which both series of experimental plots were taken, is at once noticeable as being decidedly rich in chalk or "lime." The analysis of the two soils are given below, together with the values quoted by Griffiths for the soil upon which his experiments were carried out.

FIG. VII. SOIL ANALYSES.

	Series I. Wye (Gardens.	Series II. Wye (Field).	Griffiths.
Moisture, per cent.	2.20	2.57	2.71
Loss on ignition, per cent.	5.32	5.05	4.91
Nitrogen, per cent.	.196	.224	—
Ferric Oxide, per cent.	3.82	3.94	2.13
Lime as calcium carbonate, per cent.	10.44	44.6	3.25

It will be seen that the main differences between the values given occur under the heading of lime as calcium carbonate (chalk). The value in Series I. is decidedly on the high side for average soils, while the 44.6 per cent. obtained for the soil of Series II. is excessive. Now it will be recalled that in Griffith's results, quoted above (page 280, v.) it is mentioned that the method for correcting the accidental addition of an excess of ferrous sulphate is to add lime or chalk, hence indubitably the presence of an excess of this constituent in the soil experimented upon is to render inoperative any effect that might have resulted from treatment with ferrous sulphate.

It is not proposed to advance here a full theory to account for this inhibitory effect of chalk in the present state of our knowledge of the mechanism of the action of catalytic fertilizers, but the following suggestion may be tentatively offered.

This action is possibly due to a double decomposition taking place between the chalk and the ferrous sulphate, thus,

$$\text{(i) } FeSO_4 + CaCO_3 = FeCO_3 + CaSO_4.$$

The ferrous carbonate so produced speedily parts with carbon dioxide to give ferrous hydroxide, this substance then undergoing oxidation by the air to ferric hydroxide, slightly increasing the proportion of this substance invariably present in all soils.

$$\text{(ii) } FeCO_3 + H_2O = Fe(OH)_2 + CO_2.$$

$$\text{(iii) } 2\ Fe(OH)_2 + H_2O + O = 2\ Fe(OH)_3.$$

The greater the amount of chalk in the soil, the more rapid the decomposition of the ferrous sulphate, and consequently the smaller the effect of that compound upon growing plants.

The same chemical changes would take place in all soils, but the rapidity of reaction (i.) given above would directly depend upon the amount of calcium carbonate present. This would be the case without making any assumption as to the nature of the action on the plant of the ferrous sulphate, that is to say, whether such action is a stimulative one depending upon the presence of *ferrous* iron, or whether it simply is due to a temporary increase in the amount of *soluble iron* compounds in the soil.

Quality of the Potatoes.—Although no effect was noticeable as regards any increase in yield as a result of treatment with ferrous sulphate, it was thought advisable to extend the investigation of determining whether there was any difference in the quality between the various samples.

The potatoes after peeling were boiled in saucepans, and the quality of the tubers was then compared, noting such points as appearance, texture, flavour and colour, and giving marks for the different features. There was found to be no noticeable variation between the samples taken from the different plots that could be attributed to treatment or non-treatment with ferrous sulphate, all the tubers being of good average quality.

Composition of the ash of the potatoes.—Griffiths found, in addition to the effect of ferrous sulphate on the yield of potatoes, that the composition of the ash of the potatoes on the treated plots was uniformly different from that of those

on the untreated plots. Amongst other points, it was noticed that the percentage of iron was greater in the case of the tubers on the treated plots, and that, moreover, as the percentage of iron increased, so the proportion of potash decreased. It seems, therefore, as if the iron were directly assimilated in larger amounts when it was presented in greater proportion, and in addition, that the iron could to a certain extent play the part of potash and replace it in the metabolism of the plant.

Representative samples of tubers from the different plots of Series II. above were incinerated in a muffle furnace, and the ashes subjected to analysis with regard to their content of potash, phosphoric acid and iron, with the following results :

FIG. VIII.

Plot.	Phosphoric Acid (P_2O_5) per cent.	Iron (Fe_2O_3) per .cent	Potash (K_2O) per cent.
A (treated)	9·90	·54	54·54
B (untreated)	11·76	·54	54·94
C ,,	11·04	*1·17	55·44
D (treated)	10·91	·69	56·40
E ,,	11·39	·31	58·34
F (untreated)	9·99	·37	51·57
G ,,	9·44	·49	46·79
H -(treated)	10·23	·37	54·18
Average for treated plots	10·61	·47	55·86
Average for untreated plots	10·56	·47	52·19

* Neglected in averaging.

An analysis of these figures shows that the treatment with ferrous sulphate had no effect upon the percentages of phosphoric acid, iron or potash, nor is there evident any such relation between the amounts of iron and potash as was found

by Griffiths. This is, however, what might be expected, considering that the treatment had no effect upon the yield of the potatoes or their quality.

Summary of conclusions.—(1) Under the conditions stated above, the use of ferrous sulphate as a top dressing on potatoes is found to give no increase in yield up to $\frac{3}{4}$-cwt. per acre of the iron salt, nor is there found to be any alteration in the quality of the tubers after cooking, or in the composition of their ash after incineration.

(2) The work of Griffiths, Boullanger and others has not therefore been confirmed under the various conditions that obtained in the series of experiments described. The present work should not, however, be regarded as disproving the results of the above investigators, but should be rather looked upon as supplementary to them, in that it shows that the results of the use of ferrous sulphate are not the same under all conditions, but depend upon variations in the soil and possibly other factors.

(3) As a tentative theory is advanced the suggestion that the effect of ferrous sulphate is considerably affected by the amount of calcium carbonate in the soil experimented upon, the larger the amount of calcium carbonate the less the effect of the ferrous sulphate. This is probably due to a chemical action between the calcium carbonate and the ferrous salt, whereby ferric oxide is produced by oxidation more quickly than would otherwise be the case.

(4) Experiments similar to the above must be repeated upon other soils containing notably a much smaller percentage of chalk before anything in addition to the above can be definitely stated.

In conclusion, the writer's acknowledgments are due to Mr. R. H. Carter, M.S.E.A.C., for the care with which he performed the ash analyses, also to Mr. H. C. Chapelow for his kindness in judging the cooked tubers.

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THE VALUATION OF BASIC SLAG.

By D. R. Edwardes-Ker, B.A., B.Sc.

The recent libel case in the King's Bench Division, and the expert evidence given therein, has doubtlessly exercised many in their minds as to the validity or not of the generally accepted method for the valuation of the well-known and popular phosphatic fertilizer known as basic slag.

As the law stands at present, the vendor of this material is compelled to give a guarantee of the percentage of phosphoric acid dissolved by treatment of the substance with a 2 per cent. solution of citric acid for half an hour, under certain specified conditions, and hence the custom has arisen of valuing basic slag according to this guarantee of citric-soluble phosphoric acid or phosphate. It cannot be doubted, however, that no sample of basic slag ever put on the market would have all its phosphoric acid extracted by the citric acid solution under the prescribed conditions, and chemical investigations have shown that this method of analysis brings about no absolute separation between the different phosphates in the slag, no actual compound that can be regarded as possessing any special fertilising virtue being removed in this way. It is simply a sufficiently good practical means of estimating what proportions of phosphoric acid are readily soluble, in a comparative sense alone. The question remains as to what is the fertilizing value, if any, of the phosphates remaining unextracted by the treatment, and if these insoluble phosphates *are* of fertilizing value, what monetary value should be attached to them per unit ?

It was upon the first of these two queries that the major part of the expert evidence in the trial quoted above really hinged, but the reports published in the different papers and

periodicals were of such a conflicting nature, and the various points so legally involved, as well to leave in the mind of the average man a doubt as to whether the citric solubility test is, or is not, of value as a means of arriving at the price per ton that should be affixed to the different slags on the market.

In these days of high farming, agriculturists, requiring fertilizers that generally give a rapid return for the money paid, are more often than not asked, and are willing to give, a higher price per unit in the case of those materials that are most rapid in their action. To take a case in point, the present value per unit of phosphate in superphosphate is 1s. 9d., while in the case of mineral phosphates the price asked is often as low as 9d.; both these materials, however, supply to the soil the same manurial constituent, the difference in the prevailing price depending solely upon the fact that the phosphate in "super" is many times quicker in action than that in the mineral or insoluble phosphates.

The same is found to apply in the case of nitrogenous manures also, the unit of nitrogen in the rapidly acting nitrate of soda commanding a higher price than in average shoddies. In this case, however, the organic matter in the shoddy, and the beneficial result arising from its application, tend to a higher price than would otherwise be obtained; for this reason, in the highest quality shoddies the unit price (calculated on the nitrogen) may be higher than in nitrate of soda.

Allowing, therefore, that, other things being equal, rapidity of action and price go more or less hand in hand, it may be instructive to enquire as to what quickness of action of a fertilizer is due.

Excepting in the case of those substances like sulphate of ammonia, which, although soluble in water, have to undergo a chemical change in the soil before they can serve as direct plant foods, it may be definitely stated that *quickness of action depends upon rate of dissolving in soil water.* Since plants obtain their nourishment from the soil in the form of solutions in water, those fertilizers which dissolve most quickly are presented to the plant in an assimilable form more rapidly, and any effect following their application is thus sooner evident.

Applying this connection between solubility, rapidity of action, and market price to the case of basic slag, one arrives at the conclusion that the valuation of this substance should, partly at least, have as a basis the solubility of the phosphates therein.

Now, although basic slag, as far as its phosphate is concerned, is insoluble in pure water, it undergoes a fairly complete solution when subjected to the continuous action of soil water, a substance possessing a greater solvent action than pure water owing to the carbonic acid and possibly other compounds which it contains.

Obviously, therefore, an ideal method to arrive at those proportions of phosphoric acid soluble in soil water and therefore of immediate use to the plant, would be to use soil water as the extractive agent in the analysis of the material. This is, however, impracticable, and an artificial solution approaching as nearly as possible in solvent action that of soil water has to be employed instead.

Attempts have been made to use a solution of carbonic acid of similar concentration and solvent action to soil water, prepared by sufficient dilution of ordinary "soda" water made in a sparklet syphon. Unsatisfactory results were, however, obtained, owing partly to the difficulty of keeping up the concentration of the carbonic acid, which tends to lose gaseous carbon dioxide with a consequent fall in acidity and solvent power. The investigator who carried out these experiments (J. K. S. Dixon, *Jour. Agric. Sci.*, Vol. I., page 430) said that "although the natural solvent in the soil is carbon dioxide (carbonic acid), it is not possible in the case of basic slag to make use of it as a solvent for determining the phosphoric acid. Owing to the small mass of the carbon dioxide entering into the reaction, the extent to which the phosphates are attacked is masked by the presence of the varying quantities of free lime . . ., the slag containing the least quantity of free lime showing the highest percentage of phosphoric acid soluble."

A solution, however, that is easily prepared, and one which has a similar dissolving action to soil water, is 2 per cent. citric acid. The results obtained by the use of this solution are very reliable and constant, and the free lime always present

in slags does not exert an appreciable disturbing effect. It may be contended that as there is no citric acid in soil water, the use of this substance would lead to untrustworthy results, but it may be pointed out that citric acid is very similar to carbonic as regards strength and solvent action, and provided the concentration of the solution is correctly adjusted, the solvent action of soil water may be almost exactly simulated. It might also be pointed out that the time during which the solvent is allowed to act on the slag (half an hour) is entirely conventional and arbitrary, and is not at all comparable to the solvent action in the soil, a process taking place without cessation. This is, of course, true ; even in the case of the most soluble slags, the process of solution is not complete in half-an-hour, as shown by the following figures obtained in the laboratory :—

BASIC SLAG CONTAINING 43·71 PER CENT. TOTAL PHOSPHATE OF LIME.

Phosphate of lime extracted by a 2 per cent. citric acid solution in	½-hour	33·73 %
	1 hour	36·31 %
	2 hours	38·06 %

The fact of the case is this ; it is quite impossible to reproduce in the laboratory the actual conditions obtaining in the soil, but for the purpose of *comparison* of the amounts of readily available phosphate in slags as a means of arriving at their value, the citric acid extraction as carried out according to the conditions laid down by the Board of Agriculture is quite satisfactory and trustworthy, and may be confidently recommended as a *partial* method of valuation.

Should, however, the valuation of basic slags be confined simply and solely to the " citric soluble " phosphoric acid, or in other words, is the phosphoric acid remaining unextracted after the half-hour's treatment to be neglected in a plan of valuation ?

This, of course, depends upon the fate of those unextracted phosphates in the soil, whether they remain insoluble, and hence of no value as plant foods, or whether they progressively dissolve, furnishing a gradual supply of soluble phosphoric acid, in the same way that shoddy furnishes a gradual supply of nitrogen.

As shown by the above figures, and also depending upon the fact that the "insoluble" phosphates are partly at least of identical chemical composition to those extracted, it may be stated that undoubtedly the "insoluble" phosphates do gradually dissolve in the soil, whether completely or not it is at present impossible to say; it is at least certain, however, that half-an-hour's extraction does not by any means represent the sum total of the phosphates that will dissolve in the soil, and consequently a rational basis of valuation should not be calculated *only* on the amount of phosphates removed during the half-hour's treatment with citric acid.

Even in the case of certain insoluble (as they are called) phosphatic manures on the market, which are definitely stated by the manufacturers to be insoluble in the prescribed citric acid solution, it is found that progressive treatment with this solution leads to an extraction of a certain proportion of phosphates, as the following figures will show:—

An Insoluble Phosphate Containing 36.23 per cent. Total Phosphate of Lime.

Phosphate of lime extracted by a 2 per cent. citric acid solution in	½-hour	1.61 %
	1 hour	2.86 %
	1½ hours	3.28 %
	2 hours	4.02 %

It seems reasonable, therefore, to fix some direct monetary value to that percentage of phosphoric acid which, while not soluble in citric acid solution in half-an-hour, will presumably

be dissolved if the treatment be prolonged. When one considers that this subjection to solvent agencies takes place interminably in the soil, it is only fair to conclude that sooner or later all the "insoluble" phosphate dissolves and becomes available as plant food.

It is not proposed, of course, to attach the same value per unit of phosphate in the two cases of the "soluble" and "insoluble" phosphates. The "soluble" phosphates undoubtedly act more quickly, hence lead to a quicker return on the outlay, and should be valued accordingly; the "insoluble" phosphates, on the other hand, should not be looked upon as worthless, but should be given a certain definite but lower value. As to what this value should be depends upon the rate at which the "insoluble" phosphates dissolve, and until this has been determined, it would be feasible to attach some such value as applies to the unit of phosphate of lime in such materials as meat guanos, mineral phosphates (*i.e.*, 9d. per unit).

In a word, therefore, it is suggested that in place of the method of valuing basic slags only on the phosphate soluble in 2 per cent. citric acid in half-an-hour, that the *total* phosphate be in addition determined analytically, and that a value of, say, 9d. per unit of phosphate of lime be given to the percentage of insoluble phosphate (*i.e.*, the difference between the total phosphate and the citric soluble), a proportionately lower value than that usually adopted being taken for the unit of citric soluble phosphate, say 1s. 7d.

REPORTS

FROM THE

BOTANICAL DEPARTMENT.

WEEDS IN SEED SAMPLES.

BY

S. T. PARKINSON, B.Sc., AND GEORGE SMITH, B.Sc. (Agric.)

The object of this paper is to draw attention to the importance of examining seed samples for purity before purchasing seed and to help the farmer to recognise the most commonly occurring " noxious " weeds.

The subject of purity of seeds is awakening a certain amount of public interest at the present time. The deputation which was received by the Right Hon. Walter Runciman at the Board of Agriculture on May 6th urged very strongly the need for a National Seed Testing Station, and was very emphatic as to the necessity of being able to obtain guarantees of the purity of seed samples.

It seems that Continental and American buyers demand a guarantee when buying English seed, whereas English farmers are often quite willing to do without one.

The deputation urged that there should be one National Seed Testing Station, so that all guarantees should be made by one fixed standard, and settled by an authority that would be final. The objection to the work being done by Agricultural Colleges was that twelve Colleges mean twelve standards.

A uniform standard test is certainly necessary, the difficulty of drawing up such a standard test for use by different Institutions is certainly great, but hardly insuperable, and it may be as well to point out that the seed testing done at Agricultural Colleges is not only useful *per se*, but it is of distinct educational value to the farmer, for it gives to students who will eventually be farmers themselves an opportunity to become acquainted with the impurities observed in

average samples and if, as is the case at this College, the weed seeds are sown in a specimen garden, or in pots, it enables the student and others to recognise the weed plants themselves, with their mode of growth. Such knowledge often facilitates the destruction of obnoxious weeds.

A National Seed Testing Station would meet the requirements of the merchant and the grower ; it would give him a guarantee by which he could sell in foreign markets, but it would do little to spread a knowledge of the weeds and it will not produce a clean crop. We suggest that side by side with seed testing must go the education of labourer and farmer, for though the seed be perfectly pure that alone will not produce a clean crop, the land has a heritage of weeds.

From the point of view of the labour and the expense for cleaning the land they involve, weeds are a source of endless trouble. " One year's seeding ; seven year's weeding " is a proverb so often quoted that it has become trite, yet comparatively few seem to realize how many injurious effects and how considerable a financial loss is involved by the introduction of weed seeds on the land.

However, the " Seed Control Stations," and the " Seed Control Acts " of Canada and other nations show that in some countries, at any rate, the matter has claimed and held the attention of practical men, and it may be well to draw attention to some aspects of the matter here.

The trouble and cost of cleaning untidy land is but a part, and sometimes but a small part, of the penalty we pay for introducing weeds. Their injurious effects are manifested in various ways. They shade young and growing plants from light and air. Want of light means want of food for the plant, so that it grows up slender and sickly-looking, becomes " drawn up " and liable to " lodge."

Perhaps root crops, which are the slowest of all farm crops to gain height, suffer most severely from this cause, and this is the reason they need to be thinned out well, and kept free from weeds.

Another effect is that weeds remove from the soil water and other substances which are essential to the establishment of the young crop. This is especially the case in dry weather, when competition for moisture is keenest and when the weeds

which are natural and best adapted to the soil easily gain on the more delicate and less adapted crop. Charlock is a frequent sinner in this respect, and with regard to oats, Schultz, experimenting in 1909, estimated that in one case the loss due to the presence of that weed was 33 per cent., and in another case as much as 67 per cent. of the crop. So that half a crop of oats may be lost in this way. Clinging, and fibrous and woody weeds, such as thistles, docks and sorrels charlock and runch give special trouble in connection with mowing and harvesting operations.

Two weeds, at any rate, Dodder and Broomrape, if introduced as seed, become parasites, feeding on the clover crop until it is practically all destroyed; and if, in the case of Dodder, the remnant of the crop is harvested, it is so wet that the stack practically never dries. In other countries governments enforce legal penalties for introducing Dodder in seed, thus recognising that it is somewhat of the nature of a crime to sow it.

Insect pests, such as the Turnip Flea, and fungus pests, such as Finger and Toe, may be harboured and encouraged by certain species of weeds. Again, certain weeds growing up with the crop render its seeds impure and so decrease their market value and in some cases render them poisonous.

It is important to prevent new kinds of weeds from being introduced on our farms. Instances are known where foreign plants have proved noxious pests to the farmer. Such weeds may be introduced with commercial seed from abroad or with feeding stuffs, or by worthless poultry food,* or by screenings bought at some port and fed to poultry, or they may be carried with stable manure or threshing machines or other farm inplements. At the present time, when seed is obtained from so many countries, we must consider that by the use of impure seed we may be introducing some noxious foreign weed that eventually may become as troublesome as the thistle or the dodder are at present.

Considerations of this sort have, in other countries, led to organized methods for the grading of seed samples and preventing the sale of notoriously impure seed and in some

* See *Journal* for 1907, p. 262. "Chick Food," by S. T. Parkinson.

instances have culminated in the passing of legislative measures for Seed Control.

A most interesting report,* published in 1911 by the Seed Commissioner for the Dominion of Canada, affords very instructive reading in this connection. In that country the problem has been attacked on very enterprising and practical lines. Side by side with investigations into the conditions of the seed trade and with the testing of seeds for farmers and seedsmen, a well planned educational campaign has been carried out for encouraging the production and use of better seed.

Resulting from the knowledge thus disseminated, demands arose in various quarters for State Interference in the matter of the sale of seed, and finally a " Seed Control Act " providing for the inspection and sale of seed and for grading seed samples by fixed standards of quality was passed.

Whether, with a fuller knowledge of the subject, there would be a demand for such legislation in this country seems very doubtful. Even if there were such a demand there are still grave objections to State Legislation in such matters, but the spread of a wider knowledge of the subject is certainly necessary if we are to protect ourselves from the importation of bad seed from abroad, and a " National Seed Testing Station " would be a very valuable institution. That this is the opinion of many practical men is evidenced by the nature of the deputation to the Board of Agriculture already referred to.

In Canada in 1900 a three-year Seed Competition for boys and girls was organized. At the close of the competition farmers and the parents of competitors were invited to form a " Seed Growers' Association " for the encouragement of production of high-class seed and for the registration of seed grown under approved methods; and a temporary organization, " The Macdonald-Robertson Seed Growers' Association," was formed in 1903. The issue of the certificate and inspection of seed plots was controlled by the Commissioner of Agriculture. In 1904 the " Canadian Seed Growers' Association " was established on a permanent basis. In

† "Report of the Seed Commissioner for the Period 1905-1911." Agriculture Department for the Dominion of Canada, Ottawa.

1902 "Seed Fairs" and a "Seed Laboratory" had been established. In 1905 the "Seed Control Act" was passed, providing that seed offered for sale must be free from certain specified noxious weeds or else be labelled as containing them; it also provided for the "grading" of seeds, and in 1911 an amendment was passed providing for definite fixed standards of quality.

The *Report* claims that since the Act came into force there has been a marked change for the better in the grass and clover seed trade in Canada. On page 8 of the *Report* we read:—
"The investigation showed clearly that a large proportion of the seed merchants as well as farmers were not able to identify even the most common weed seeds and therefore often sold clover and grass seed that was badly contaminated without knowledge of its harmful nature. In order to provide them with means of identifying weed seeds and determining the purity of their seeds, *reference collections* containing samples of one hundred different kinds of weeds and economic seeds were prepared by the Seed Division. These were sold at the nominal price of two dollars per set to merchants and agricultural organizations."

Now the idea of this collection of weed seeds, showing both the "noxious" weeds and the most commonly occurring other weeds seems to us most useful and practical, and one feels that the distribution of such a collection in this country would be of great advantage. 873 of these collections were distributed by the Canadian Agricultural Department up to March, 1911.

Much information about British weeds may be gained from the various leaflets issued by our own Board of Agriculture, and in the *Journal* of that Board, but nothing comparable to the "Farm Weeds of Canada," published in 1906, has yet appeared. Sold for one dollar, the book is well worth the money and must have cost far more to produce. 25,000 copies of this book were produced and of these 15,000 copies were distributed to the libraries of rural schools where they are available for use.

Mere verbal descriptions or black and white *drawings* of weed seeds are of but little use for identification purposes. The ideal thing would be *coloured photographs* of the seeds

magnified, but as the difficulties of producing such are too great it is hoped that the photographs reproduced in this article of a few of the weed seeds, together with the verbal descriptions, will be found to be sufficiently intelligible to the practical man. The seeds to be identified should be examined with a lens magnifying at least ten times.

The economy effected by sowing pure seed is twofold, in the first place it often means a heavier and better crop with less cost for cultivation, cleaning and harvesting, and in the second place it means better prices if the crop is to be sold for seed.

This is an important consideration for those who desire to sell to seed merchants, a pure sample of seed being worth more and actually fetching more than an impure one.

It is often assumed that the seed merchant is responsible for the impurities and for the low quality of seeds, but although the cleaning processes at work in some of the great seed merchants' establishments have attained to a marvellous degree of efficiency, it must be remembered that some seeds are of such a size that the sieves and winnowers in general use cannot possibly remove them. Thus in Clover seed, Dock, Cranesbill, Cornflower, Selfheal and Campion cannot easily be removed, owing to their similarity in size to the clover. The elimination of these largely rests with the farmer, and much can be done in this respect by a small outlay when the crop is growing, and it pays better to grow a clean crop of seed than a polluted one.

If growers would attend to systematic eradication of weeds they would get better money for the crop and would be lifting a burden from the back of the seed merchant.

In one way or another all weeds are harmful, but it would be inconvenient, if not impossible, to eliminate all. Certain weeds, either because they possess poisonous qualities, or because of the difficulty of eradicating them when they are once established, or because they are extraordinarily prolific, or from the harm they do the crop, are marked off from the general run of plants as specially obnoxious. Amongst British plants there are not a great number which can be cited as "noxious weeds." The following list includes most of them :—

Papaver Rhœas	..	Corn Poppy.
Brassica Sinapis	..	Charlock.
Lychnis Githago	..	Corn Cockle.
Lychnis alba	..	White Campion.
Lychnis diurna	..	Red Campion.
Silene inflata	..	Bladder Campion.
Spergula arvensis	..	Spurrey.
Sherardia arvensis	..	Field Madder.
Chrysanthemum Leucanthemum		Ox-eye Daisy.
Tussilago farfara	..	Coltsfoot.
Cnicus arvensis	..	Creeping Thistle.
Sonchus arvensis	..	Creeping Sowthistle.
Sonchus oleraceus	..	Ordinary Sowthistle.
Convolvulus arvensis	..	Lesser Bindweed.
Cuscuta trifolii	..	Clover Dodder.
Orobanche minor	..	Broomrape.
Chenopodium album	..	Fat Hen.
Polygonum Convolvulus	..	Black Bindweed.
Rumex sp.	..	Docks and Sorrels.

Photographs of these generally occurring noxious weeds are given below (Plates I.—VII.), and by means of them and of the descriptions appended anyone with a little practice should be able to distinguish between these weeds without difficulty. The photographs show the seeds much enlarged, and it is necessary to use a *really* powerful magnifying lens to see the details on the seeds. Such a lens may be obtained for a few shillings from any large dealer in microscopic apparatus. It should be guaranteed to give a clear magnification of about ten diameters.

It would often be useful to the grower if he could recognize the place of origin of the seed he is offered, for a large proportion of seed sold in England is of foreign origin. Of such, Canada, New Zealand, France, United States and Germany supply the bulk.

Generally speaking, seed from a warmer climate produces tenderer plants, and farmers, when they have the choice, wisely follow the rule of bringing seed into warmer climates. Many weeds, like Docks, Sorrel, Plantain, Campion and Ox-eye Daisy are common to practically all the countries mentioned,

but there are many plants more or less *peculiar to each* separate country, and when such are recognised in a sample they often afford a valuable clue to the source of origin of the sample.

Unfortunately it is very difficult to obtain reliable lists of such weeds, and it is difficult to make up such a list from samples sent from abroad, because the seed is liable to become mixed or blended before it is sold, and the weeds of any country might occur in it.

A very useful list of weeds indicating the origin of samples is given in a list which accompanies a collection of weed seeds published by Professor Percival, of Reading College.

The following list has been compiled from lists of weeds sent to us by correspondents in various countries, and is useful as indicating the continent of origin, though it is not as satisfactory as could be desired.

OF AMERICAN ORIGIN :—

(*a*) Clover Seed.

Setaria viridis ..	Green Foxtail.
Setaria glauca ..	Yellow Foxtail.
Conringia orientalis ..	Hare's Ear Mustard.
Camelina sativa ..	False Flax (especially Canadian).
Lepidium apetalum ..	Pepper Grass.
Saponaria vaccaria ..	Cow Cockle or Soap Wort.
Silene noctiflora ..	Night-flowering Catchfly.
Ambrosia artemisiæfolia ..	Common Ragweed.
Cnicus arvensis ..	Canada or Creeping Thistle.
Echium vulgare ..	Blueweed or Viper's Bugloss.
Lappula lappula ..	Bluebur or Stickweed.
Amarantus retroflexus ..	Pigweed or Amaranth.
Acalypha virginica ..	Waxball or Three-seeded Mercury.
Oenothera albicaulis ..	Evening Primrose.

(*b*) Corn (Wheat).

Neslia paniculata ..	Ball Mustard.
Avena fatua and *strigosa* ..	Wild Oats.
Polygonum persicaria ..	Persicaria or Lady's Thumb.
Rosa pratincola ..	Prairie Rose.

Euphorbia sp.	..	Spurge.
Plantago aristata	..	Bracted Plantain.
Ambrosia artemisiæfolia	..	Ragweed.
Ambrosia trifida	..	Tall Ragweed.
Sida Spinosa	..	Spiney Sida.
Helianthus sp.	..	Prairie Sunflower.

EUROPEAN.

Stellaria media	..	Chickweed.
Lynchnis sp.	..	Forked Catchfly.
Lynchnis alba	..	White Campion.
Daucus carota	..	Wild Carrot.
Chicorium intybus	..	Chicory.
Sherardia arvensis	..	Field Madder.
Ranunculus arvensis and other species	..	Buttercups.
Verbena officinalis	..	Vervain.
Geranium molle	..	Dove's foot Crane's-bill.
Geranium dissectum	..	Cut-leaved Crane's-bill.
Spergula arvensis	..	Spurrey.
Anagalis arvensis	..	Pimpernel.
Picris hieracoides	..	Hawkweed picris.
Matricaria inodora	..	Scentless Camomile.
Lotus corniculatus	..	Birdsfoot trefoil.
Valerianella olitora and other sp.		Corn salad.
Agropyrum repens	..	Couch.
Bromus mollis	..	Soft Brome Grass.

SPECIAL AREAS :—

HUNGARY.

Ervum hirsutum.		
Adonis æstivalis	..	Pheasant's Eye.
Lithospermum arvense	..	Corn Gromwell.
Allium.		
Bifora radians.		
Delphinium consolida	..	Larkspur.
Melampyrum arvense and *orientale*	..	Cow Wheat.
Polygonum lapathifolia	..	Pale Persicaria.
Camelina dentata	..	A false flax.

ITALIAN.

Anagalis arvensis	..	Pimpernel.
Galium verum	..	Lady's Bedstraw.
Verbena officinalis	..	Vervein.
Rapistrum rugosum.		
Lathyrus aphaca	..	Yellow Vetchling.

DANISH.

Resemble English.

Dodder (*Cuscuta*) is found in most European samples but is removed by screening. No seed containing Dodder should be purchased.

With regard to the general examination of a sample for purity the following lists summarised from information specially supplied to us from several sources indicate seeds that may be expected to occur commonly in samples sold in this country.

Grass mixtures are likely to contain seeds of all the common weeds that occur in Clovers. They are sometimes adulterated with inferior and cheaper grass seed and the lists include grasses used for adulteration. Many of them are quite worthless for pastures or hay and some are deleterious.

Mangel seed is not often adulterated and should be judged on its germination capacity, as old seed may be mixed up in it. Similarly, as a general rule, turnip and swede seed is fairly pure, but the germination capacity should be tested to detect old seed.

What to look for in Clovers :—

Ranunculus sp.	..	Buttercup.
Vicia sp.	..	Tares.
Lathyrus sp.	..	Vetchlings.
Papaver rhœas	..	Poppy.
Trifolium minus	..	Suckling Clover.
Stellaria sp.	..	Chickweeds.
Rumex acetosella	..	Sorrel
Rumex crispus and *obtusifolia*		Docks.
Lychnis alba	..	White Campion.
Silene noctiflora	..	Night-flowering Catchfly.
Lapsana communis	..	Nipplewort.

Anthemis cotula	..	Stink Mayweed.
Chrysanthemum leucantheum	..	Oxeye Daisy.
Senecio Jacobea	..	Ragwort.
Cnicus arvensis	..	Creeping Thistle.
Plantago rugellii	..	Rugel's Plantain.
Plantago arestata	..	Bracted Plantain.
Prunella vulgaris	..	Selfheal.
Daucus carota	..	Carrot.
Sherardia arvensis	..	Madder.
Ambrosia artemisiæfolia	..	Ragweed.
Cuscuta trifolii	..	Dodder.
Setaria viridis and *glauca*	..	Foxtail.
Phleum pratensis	..	Timothy.
Geranium dissectum	..	Cut-leaved Crane's-bill.
Geranium Molle	..	Dove's-foot Crane's-bill.
In Lucerne :—		
Medicago lupulina	..	Black Medick.
Vicia sp.	..	Tares.
Polygonium convolvulus	..	Black Bindweed.
Convolvulus arvensis	..	Lesser or Convolvulus Bind weed.
Cuscuta sp.	..	Dodder.
Cnicus sp.	..	Thistles.
Centaurea nigra	..	Knapweed.
Amaranthus retroflexus	..	Pigweed.
Lappula lappula	..	Stickseed.
Daucus Carota	..	Carrot.
Sherardia arvensis	..	Madder.

WEEDS COMMON IN ALL SEEDS (GENERAL) :—

Lychnis Githago	..	Corncockle.
Lychnis sp.	..	Campions.
Ranunculus sp.	..	Buttercup.
Galium aparine	..	Cleavers.
Rumex sp.	..	Docks.
Polygonum convolvulus	..	Bindweed.
Convolvulus arvensis	..	Bindweed.
Cnicus sp.	..	Thistles.
Sonchus sp.	..	Sow thistles.
Crepis sp.	..	Hawkweed.

Picris sp. ..	Hawkweed.
Myosotis sp. ..	Forget-me-not or Scorpion Grass.
Chrysanthemum leucanthemum	Oxeye Daisy.
Lapsana communis ..	Nipplewort.
Avena fatua ..	Wild Oats.

GRASSES (OCCASIONALLY USED AS ADULTERANTS) :—

Anthoxanthum Puellii ..	Puells vernal.
Alopecurus agrestis ..	Slender Foxtail or Black Bent.
Holcus lanatus (in glumes and naked) ..	Yorkshire Fog.
Aira Cæspitosa ..	Tussock Grass.
Aira flexuosa ..	Wavy Hair Grass.
Lolium perenne ..	Per. Rye Grass.
Bromus mollis ..	Soft Brome.
Molinia cærulea ..	Lavender Grass.
Festuca sp. ..	The Fescues.

And the general weeds are often present.

DESCRIPTIVE LISTS OF COMMONLY OCCURRING NOXIOUS WEED SEED.

The number of the description is the same as that attached to the photograph of the same seed in the Plates.

The magnification of the seed is indicated in the photograph by a cross and the number of times the photograph is longer than the original seed, *e.g.*, × 15, means that the photograph is fifteen times the length of the original seed. Seeds from the same plant vary much in size. The sizes given are those of an average-sized seed and expressed in inches and millimetres.

The largest diameter of the seed is given as the size and they are described as

Minute if less than $\frac{1}{64}$ in. in length.
Small if less than $\frac{1}{32}$ in. in length.
Medium if less than $\frac{1}{16}$ in. in length.
Large if less than $\frac{1}{8}$ in. in length.
Very large if more than $\frac{1}{8}$ in. in length.

The Colour given must often be regarded as an indication of that of a massed sample since colour varies according to age and degree of maturity. When a very characteristic shape is found, an attempt has been made to describe it, but the shape is best determined by looking at the photograph.

I.—WEEDS IN SAMPLES OF BRITISH SEED.

1. *Papaver Rhœas* (Corn Poppy).

An annual plant common on arable land. Size, $\frac{1}{32}$ inch, .75 mm. Small. Reddish-brown to slate-grey. Kidney shaped. Surface mesh-like, due to concentric rows of minute pits.

2. *Brassica Sinapis* (Charlock).

A bad weed on arable land. Size, medium, $\frac{1}{16}$ inch, 1.5 to 2 mm. Reddish-brown to black. Spherical. Difficult to distinguish from Turnip. Surface very smooth, slight roughness seen with a very strong lens.

3. *Lychnis githago* (Corn Cockle).

An annual weed in arable land. Reputed poisonous. Size, very large, $\frac{1}{8}$ inch, 3.5 mm. Dead-black, yellow to reddish when unripe. Surface covered with blunt spinous projections. Coiled appearance (see photograph). Distinguished from the next three seeds by size.

4. *Lychnis alba* (White Campion).

Biennial weed of arable land, specially troublesome after cereals. Size, medium, $\frac{1}{16}$ inch, 1.5 mm. Dull; pale buff to greyish buff. Somewhat kidney-shaped. Well marked concentric lines of warts. Distinguished from Red Campion by colour.

5. *Lychnis diurna* (Red Campion).

A weed of arable land. Size, slightly smaller than preceding and distinguished from it by its greyish-black colour and the spines being closer and more hedge-hog-like.

6. *Silene inflata* (Bladder Campion).

Size, medium large, a full $\frac{1}{16}$ in.; 1.75 mm. Dull; greyish brown to black. Distinguished from preceding seed by possessing a large peg-like structure in the notch.

7. *Spergula arvensis* (Spurrey).

An arable weed of light and acid soils. Size, medium large, $\frac{5}{64}$ in.; 1.8 mm. Smooth and dull black. Bicon-

vex and disc-like with a lighter coloured equator-like rim running round the edge. Often with minute light-coloured flakes on surface.

8. *Sherardia arvensis* (Field Madder).

Annual weed of arable land. A very common impurity. Size large; body of fruit, $\frac{1}{16}$ inch, with crown, $\frac{3}{32}$ inch. 2 and 3 mm. Greyish blue, hairy, with white prominent ribs and well-marked spiny, cup-like crown.

9. *Chrysanthemum leucanthemum* (Ox-eye Daisy).

A perennial weed, should be noticed because of its frequent appearance in mixtures. Size, medium, but long, $\frac{5}{64}$ inch; 2.5 mm. General French gray. Note the dark body and light ribs.

10. *Tussilago farfara* (Coltsfoot).

Typical of moist heavy soils. Size, large but very narrow, $\frac{5}{32}$ inch, without silky pappus; 4 mm. Dull yellow, very light and fragile in appearance. Longitudinal ridges prominent. The silky pappus generally lost in winnowing.

11. *Cnicus arvensis* (Creeping Thistle).

Arable and pasture weed. Difficult to eradicate. Size, large, $\frac{1}{8}$ inch; 3.5 mm. Shiny, silky brown appearance. Very smooth. Top has a yellowish rim surmounted by nipple-like projection.

12. *Sonchus arvensis* (Creeping Sowthistle).

Arable land. Difficult to eradicate. Size, large, less than $\frac{1}{8}$ inch; 3.8 mm. Light brown. Note shape in photograph. Flattened, longitudinal ribs without visible transverse markings. Sometimes with pappus.

13. *Convolvulus arvensis* (Lesser Bindweed).

Weed of arable land. Difficult to eradicate on account of underground stem. Roots deep in light soils. Size, very large, $\frac{5}{32}$ inch; 4.5 mm. Dull black. Flask-shaped, though somewhat angular and a longitudinal ridge on one side.

14. *Cuscuta trifolii* (Clover Dodder).

A parasite weed very destructive to Clover crop. Size, the smallest of the Dodders. Very small, $\frac{1}{32}$ inch, .7 mm. Colour of light dirt, and the shape is somewhat like the preceding, but rather globular than flask-like. This seed may be easily mistaken for a fragment of light-coloured soil. It can be distinguished by slight pressure with the blade of a penknife. Soil would crumble into dust when pressed.

15. *Orobanche minor* (Broomrape).

A very destructive parasite on Clover and Lucerne plants. Minute, $\frac{1}{100}$ inch; .25 mm. An irregular brown-pitted seed but it is so microscopic that it is difficult not to overlook it.

16. *Chenopodium album* (White Goosefoot, Fat Hen, or Lamb's Quarters).

An annual plant, common on arable land. Size, medium, $\frac{1}{32}$ to $\frac{3}{64}$ inch; 1 to 1.5 mm. Black, some shiny, some dull. The latter show radiating marks. Circular and flattened with a beak-like coil on one side. Sometimes it is found in the husk and this is shown in some of the seeds photographed.

17. *Polygonum Convolvulus* (Black Bindweed.)

A very common annual weed on arable land. Size, very large, over $\frac{1}{8}$ inch; 3.5 to 4 mm. Intensely black. A spindle-shaped seed, triangular in section, resembling Buckwheat.

Rumex. sp. (Docks and Sorrel).

These seeds are much alike, but the sorrel is a slenderer and more tapering seed. Size, medium large, $\frac{1}{16}$ to $\frac{3}{32}$ inch; 1.5 to 2.5 mm. Very shiny, chestnut brown. Much the same shape as the Black Bindweed.

18. *Rumex crispus* (Curled Dock).

19. *Rumex acetosa* (Sorrel).

II.—Common Weeds in Seed Samples from North America.

20. *Setaria viridis* (Green Foxtail).

An annual grass common on arable land. Size, $\frac{3}{32}$ inch, 2.5 mm. Medium to large. Greenish-yellow. Spindle shaped. Harsh-looking. Surface shows transverse etchings under the lens.

21. *Neslia paniculata* (Ball Mustard).

An annual common in cornfields. Size of fruit $\frac{3}{32}$ inch, 2.5 mm. Large. Dull green to brown. Irregularly spherical. Surface shows a distinctly pitted meshwork. The true seed is inside and is smooth and yellow with a very prominent germ.

22. *Ambrosia artemisiæfolia* (Ragweed).

An annual weed of general occurrence, often found amongst clover. Size, $\frac{1}{8}$ inch, 4 mm. Large, dirty brown. Pointed crown at top of seed surmounted by single large terminal spine.

23. *Anthemis Cotula* (Stinking Mayweed).

Annual plant with unpleasant smell. A very general weed on arable and clover land. Size $\frac{1}{16}$ inch; $1\frac{1}{2}$ mm. Yellowish to brown. Tapering and furrowed, the ridges warted. Character shown well in the photograph.

24. *Lapula lapula* (Stickseed).

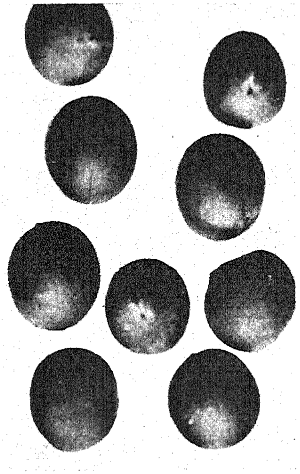
Annual—a general weed, causes trouble as a bur in wool, $\frac{1}{8}$ inch; 3 m.m. Large. Dark grey, pear shaped, angular on one side, with long spines on the othr. Spines have anchor-shaped hooks.

25. *Plantago Rugelii* (Rugel's Plantain, Pale Plantain).

Often found in Timothy and alsike seed, resembles the Common Plaintain. Size $\frac{3}{32}$ inch; 2.5 mm.; meduim to large. Dark brown to black; dull, irregularly cylindrical with one side flat showing well marked scar (hilum) and ends angular. Rough surface.

Plate I.

No. 1. × 15.



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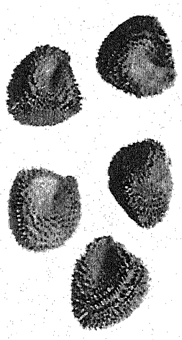

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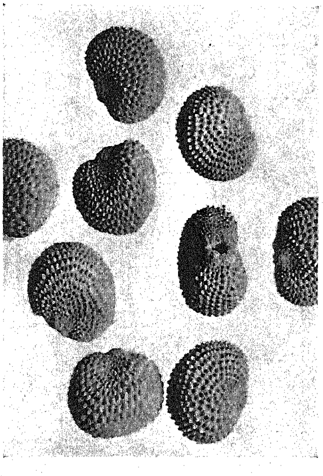

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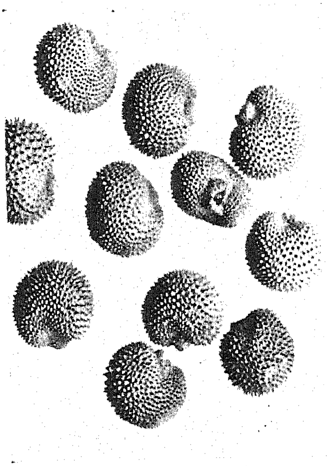

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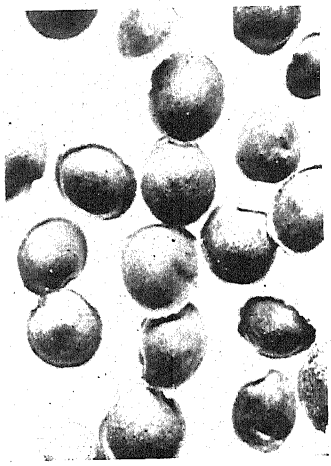
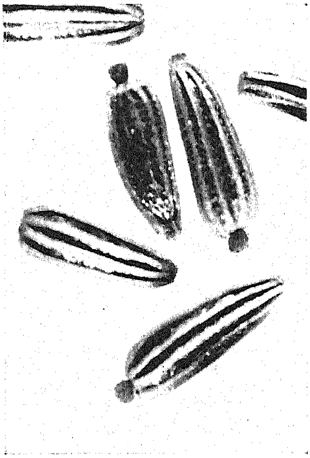
No. 6. × 12.



No. 7. × 12.

No. 8. × 12.

PLATE III.



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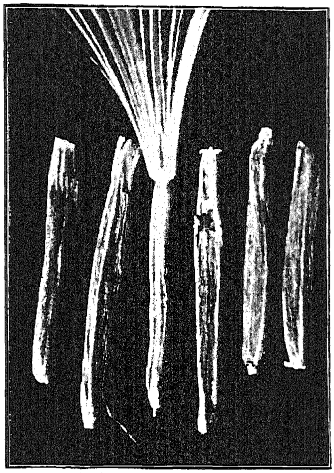

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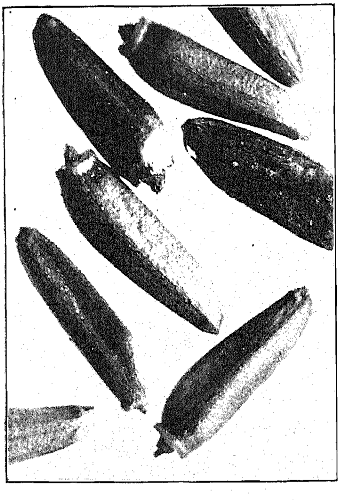

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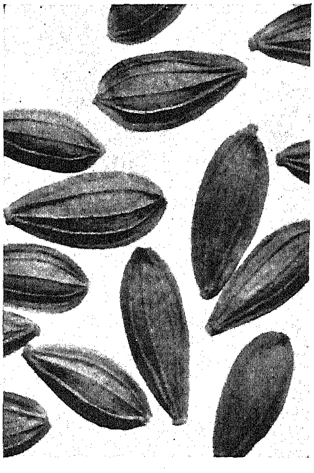
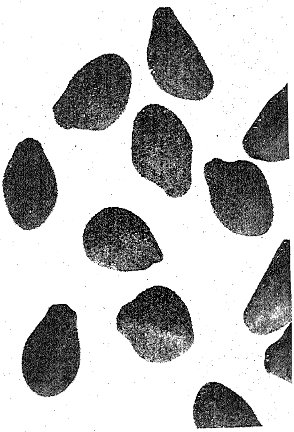


No. 12. × 12.

PLATE IV.



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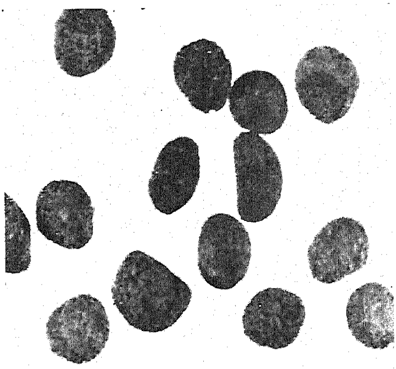

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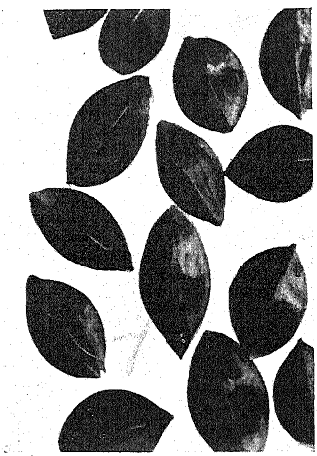
No. 15. × 12.

No. 16. × 12.

PLATE V.

No. 17. × 12.

No. 18. × 12.



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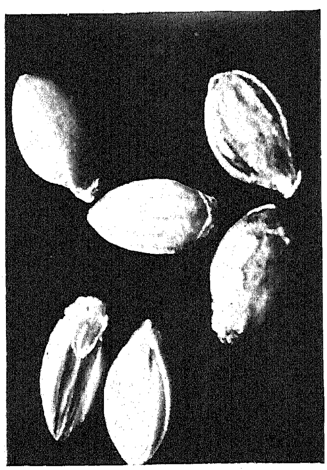

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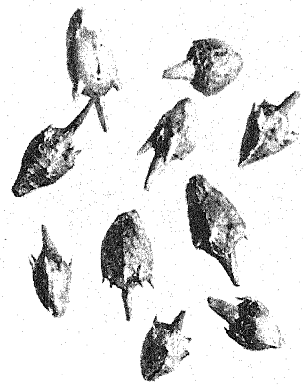
PLATE VI.

No. 21. × 12.



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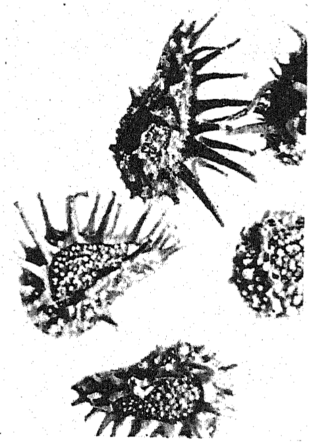

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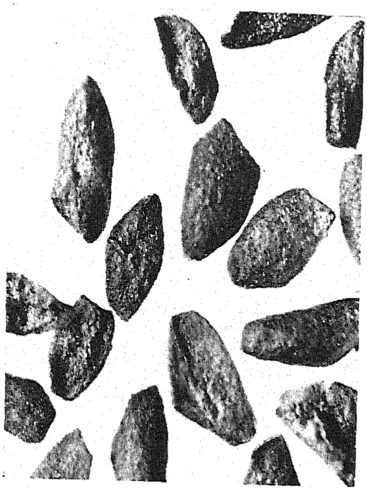
PLATE VII.



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REPORT ON

ECONOMIC MYCOLOGY

BY

E. S. SALMON, F.L.S.

CONTENTS

INTRODUCTORY NOTE.

During the past year a large number of specimens of plants affected with fungous diseases have been sent in by fruit-growers and gardeners; these have been examined and reports have been sent to the growers as to the nature of the disease and its remedy. An unusually large number of potatoes affected with bacterial and other diseases have been reported upon. In many cases visits have been made to the farm or garden and the disease studied on the spot. An occurrence of scientific interest has been the appearance on the College Farm of the "Crown-gall" disease of lucerne, caused by the fungus *Urophlyctis Alfalfæ*. The origin of the outbreak could not be traced. The affected piece of lucerne has been ploughed up. This is the third case of the occurrence of this rare fungus in Kent. A full and illustrated description of the disease is given in this *Journal* for 1906.

Advice has been sought by many growers on the subject of the best fungicide to use against apple and pear "scab," potato "blight," "brown rot" of the cherry and apple, celery "blight," American gooseberry mildew, apple mildew, peach leaf-curl, carnation and chrysanthemum rust, potato "scab," and other fungous diseases. In many cases farms have been visited and advice given on the spot as to the making and application of sprays. A large number of samples of the concentrated home-made lime-sulphur wash have been received for information as to their specific gravity and dilution for winter and summer spraying.

A considerable number of Tomato plants, affected, or suspected of being affected, with the Tomato "canker" (now a notifiable disease), have been sent in by growers for examination and report. In more than one case it has been found that towards the end of the season the old leaf-stalks frequently become infested by a fungus which produces a dense layer

of spore-bearing hyphæ (*conidiophores*), of a dirty white or greyish colour. This fungus is a species of *Botrytis*, and at times it appears to invade the tissues of the stem *and produce canker-like areas* which have a superficial resemblance to those caused by *Mycosphærella citrullina*. A species of *Botryosporium* with white conidiophores longer than those of the *Botrytis* is also to be found on the leaf-stalks, but it is doubtful if it is of a parasitic nature.

In this *Journal* for 1908 it was pointed out that the presence of a sufficient number of male hops (flowering at the same time as the hops are in "burr") is a point of some importance in connection with the control of hop "mould." If no pollen-dust from a male hop reaches the "burr," the branch remains in "burr" a long time before growing out into hop, whereas this takes place at once if pollen-dust is supplied. Now the time when hops are in "burr" represents, as every hop-grower knows, a very critical period. "Mould" may get into the "burr" and the crop be partly or wholly lost. The fact that fertilization—that is, the action of the pollen-dust on the "burr"—hastens very appreciably the "growing out" of hops, or in other words shortens the critical period when hops are in "burr," demonstrates the value of the male hop in one direction.

Since 1909 we have been supplying hop-growers in Kent, Surrey and Sussex with "cuts" of selected male hops from which a stock of male hops suitable to be planted among the various varieties can be raised. These "cuts" are sent out free to growers on application, and the following figures show the increasing extent to which our offer is being accepted.

In	1909	1,718	"cuts"	were sent	to	14	growers.
,,	1910	1,826	,,	,,	,,	27	,,
,,	1911	2,439	,,	,,	,,	42	,,
,,	1912	2,694	,,	,,	,,	58	,,

During the past few years a continually increasing number of celery plants affected with the new disease called "leaf-spot," or "blight," have been received from gardeners, asking for advice as to remedial measures. During the past season the life-history of the fungus *Septoria Petroselini*, var. *Apii*, which is the cause of the disease, has been investigated, and

some fresh facts of practical importance discovered. Spraying experiments carried out in the College experimental gardens have proved that this disease can be effectively and economically prevented by the early use of Bordeaux mixture. An account of this disease and the method of prevention are given below, at p. 329.

In my last Report I wrote: "Information has been collected with regard to a serious disease which is affecting young cherry orchards in many parts of Kent. The result of the collection and examination of material from different parts of Kent, and the evidence obtained by visits to orchards at different times in the year, have established the fact that the main, if not the sole, cause of the disease is a particular fungus called *Cytospora*, which has been reported as inflicting damage to cherry orchards on the Continent. Research into the exact nature of the attack made by this fungus have now been started by my assistant, Mr. H. Wormald, with the object of finding, if possible, some remedy." The investigations carried out by Mr. Wormald are given below at p. 367.

With regard to the American gooseberry mildew, the position of affairs in Kent—as in other counties—is very unsatisfactory. The present infected acreage for Kent is 3,294 acres; for the previous season it was 2,561 acres. The official measures decided upon by the Board of Agriculture in 1907 have not only not stamped out this new pest, but have failed to prevent it from spreading annually, until now the mildew is known in every fruit-growing centre in this country. The compulsory measures in force are of no appreciable use in clearing affected plantations of the disease, while they are costing a considerable sum of public money. Some remarks on the failure of the authorities to ensure the carrying out of the winter "tipping" of affected bushes are made below at p. 353. Fruit-growers, finding the Board's compulsory measures either too irksome or ineffectual, are beginning to show considerable dissatisfaction; in some cases they are grubbing up affected plantations, and some 150 acres have been grubbed in Kent during 1912; the county authorities concerned in carrying out the Board's American Gooseberry Mildew Orders are also naturally becoming

dissatisfied* when they find year after year that no decrease in the acreage of diseased plantations takes place.

Definite measures—whether undertaken voluntarily or under compulsion—are certainly necessary to prevent the spread of the white powdery "summer stage"—in other words, the question of summer spraying against this mildew has now become a matter of the first importance. The winter measures carried out as they have been up to the present do not prevent the mildew from appearing each spring in numerous isolated places in infected plantations scattered over the county;—if no spraying is done the mildew soon begins to spread far and wide from these primary outbreaks until by the end of the season the infected acreage is as much as, or frequently is more than, it was in the previous year.

During the past seasons experiments have been carried out at the College† with the lime-sulphur spray, as a preventive of mildew, and the results obtained during the past year will be found recorded below at p. 394. The susceptibility to injury from the use of this spray varies remarkably in the different varieties of gooseberries; some definite information has now been obtained on this point, and also on the fungicidal power of the spray. It seems probable that in certain circumstances the lime-sulphur spray will prove useful in combating the mildew. An early spraying of the infected bushes (after as much of the winter stage has been removed in the previous autumn as is advisable) with lime-sulphur towards the end of April, and again, in the case of most varieties, in the middle of May, followed by sprayings with the "liver of sulphur" solution until the berries are picked, and then again one or more sprayings with lime-sulphur, will probably be found a practical way of preventing the re-infection of the shoots with the "winter-stage" of the mildew.

It may be objected that this requires too much labour; but it must be remembered that so long as the American gooseberry mildew is in possession the fruit-grower cannot return to the old position of being able to grow gooseberries with little or no trouble.

* See p. 354.

† See this *Journal*, 1910, p. 344, and 1911, p. 419.

During the past season the Board of Agriculture, using the powers given them under "the Destructive Insects and Pests Act, 1907," have issued an Order, called the "Wart Disease of Potatoes Order, 1912," to deal with outbreaks of this most serious disease of the potato, which has been fully treated in previous numbers of this *Journal*.* The most important provisions of this Order are as follows:—No tubers shall be removed from any premises on which the disease exists until after investigations have been made. The local authority in receiving notice of the existence of the disease shall forthwith take such steps as may be necessary to determine on what premises the disease exists, and shall cause notice of such determination to be served on the occupier of each of such premises, which, within the limits specified in the notice, shall thereupon become "infected premises," and continue to be infected premises until the notice is withdrawn. The local authority may at any time and from time to time require the owner of infected premises to adopt one or more of the following measures: (*a*) to destroy any part of the crop, except the tubers; (*b*) to boil thoroughly all diseased tubers; (*c*) to take such other steps as may be considered necessary to prevent the disease being conveyed to other premises. The local authority may prohibit the planting of potatoes in the infected premises except under such conditions as may be prescribed. It shall not be lawful to use any diseased tubers for planting, or to sell or offer for sale diseased tubers for that purpose, and the removal of any tubers from the infected premises may be prohibited except under such conditions as may be considered necessary to prevent any diseased tubers being so used or sold, or otherwise disposed of for planting. A notice constituting any infected premises may be withdrawn by a notice; unless there are special circumstances, a notice of withdrawal shall not be issued as regards any premises until the expiration of three years from the date of the notice declaring the premises infected. Every person who has or has had in his possession any diseased tubers, and every person who, as auctioneer, salesman, or otherwise, has sold or offered for sale any such tubers shall, if so required, give all such information as he possesses as to the persons in whose possession or under

*Vol. XV., p. 233; XVII., p. 285; XVIII., p. 294; XIX., p. 328.

whose charge they are or have been. Every person shall be liable, on conviction, to a penalty not exceeding £10, who fails to give notification of the disease, or otherwise contravenes the provisions of the Order.

The above Order which came into force on March 30th, 1912, is to be welcomed as the first serious effort on the part of the Board to deal with the disease. It is a matter for great regret that such measures as these were not taken earlier, for outbreaks of the disease were known to the Board in 1901. Especially valuable is the provision now made for the prohibition of the planting of potatoes in infected land. By the adoption of such methods as these, which have been advocated in this *Journal* for the past six years,* the outbreaks of "wart-disease" have been stamped out in Ireland. In Great Britain, where no such steps have been taken, the disease has spread, until now over thirty counties are affected; the South of England generally is believed to be free, but small isolated outbreaks have already occurred in Surrey.

One of the most important events during the past year for the horticultural industry, has been the creation, at last, of a special Department for Horticulture at the Board of Agriculture. This is a reform which has been steadily asked for in these pages for many years. One of the duties of this Department will be to assist farmers and fruit-growers in their fight against plant diseases.

* Vol. XVII.

CELERY "BLIGHT" AND ITS PREVENTION.

(*Septoria Petroselini*, var. *Apii*).

(Plates I. to VI.)

This disease, which is commonly called Celery "Rust" by gardeners, though the fungus causing it is not a true Rust (*Uredineæ*), is one of comparatively recent appearance in this country. Other names which have been given to it are Celery "Leaf-spot," and "Leaf-scorch," and in America it is known commonly as the "Late Blight of Celery." Considering the general characteristics of the disease, the term Celery "Blight" may be advocated. It is stated to be a comparatively recent disease in the United States, being first recorded there in 1891. It is now much feared in America by celery growers, as it is found that when affected celery is put into storage the disease may still progress and inflict considerable damage, rotting off the leaves. In 1908 a loss of 1,950 car loads of celery (involving a money loss of $550,000) was caused by this disease in California alone. In this country the disease was first noticed about 1906. About that time, and for the following three or four years, a few examples of affected plants were sent in to Wye College, from places in various English counties where the disease was just beginning to appear, and was accordingly a novelty; in the succeeding years the specimens sent in became more and more numerous, until in 1910, 1911 and 1912 hundreds of "blighted" celery plants were received—frequently accompanied by accounts of the almost complete destruction of the crop. Celery "blight" is now known in most places where celery is grown, and I have found in lecturing that when the choice of the fungous diseases of vegetables to be dealt with is left to the audience, celery "Blight," or "Rust," is almost invariably chosen.

As the disease has now become so widespread, and is the cause of severe losses to celery growers, an investigation into the life-history of the fungus causing the disease was carried

out and experiments devised to test the value of spraying. The work was carried out during 1912 in the experimental grounds of Wye College. Considering the nature of the disease, it seemed probable that those measures which are so successful in preventing Potato "blight," *viz.*, early spraying with Bordeaux mixture, would be efficacious against celery "Blight." The spraying experiments described below showed that such is the case, and some striking results were obtained. A short description of the disease will be given first, and then an account of the preventive measures taken and the results obtained.

The first signs of the disease on the celery plant are small, scattered, palish spots on the leaves—at this stage of attack

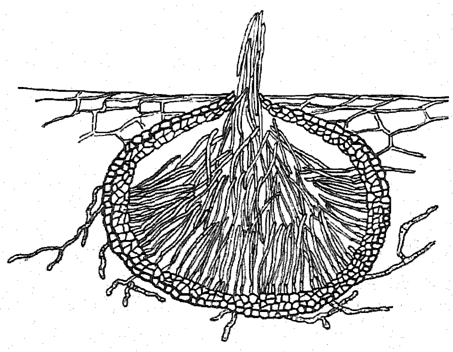

Fig. I.
Section of a fruit conceptacle (*pycnidium*) of the fungus causing Celery "blight."
(Highly magnified.)

the term Celery "Leaf-spot" is descriptive. On these pale spots numerous minute blackish bodies soon appear, which are just visible to the naked eye. These bodies are the fruit-conceptacles (*pycnidia*) of the fungus, *Septoria Petroselini*, var. *Apii*, which is the cause of the present disease. Each conceptacle contains many hundreds of very minute thread-like *spores* (see Fig. I.), which serve to spread the disease very rapidly if preventive measures are not taken. These pale spots are usually first noticed by the grower on the leaves at the end of July or beginning of August, but, as we shall see from the facts given below, are often present very much earlier.

Later in the season, that is to say during August and September, the disease increases in severity and becomes much more noticeable, for soon the greater part of many of the upper leaves becomes continuously affected, and over such diseased areas myriads of little black " dots," the *pycnidia*, are visible on both surfaces of the leaf. Sooner or later the affected leaves begin to " wilt," and turn brown, and curl up at the edges (see Plate I). At this stage, which is most characteristic of the disease, the name Celery " blight " is seen to be very appropriate. (Through the general similarity of appearance of the two diseases, I have known gardeners in several instances to suppose that the potato " blight " has passed on to their Celery—whereas, of course, the two diseases are quite

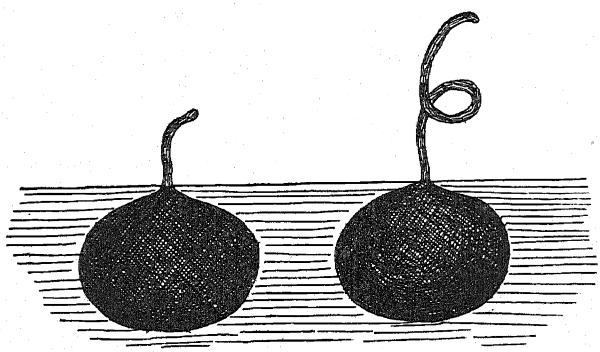

Fig. 2.
Two fruit-conceptacles (*pycnidia*) ejecting their spores in a tendril-like mass. (Enlarged).

distinct.) On such affected plants being examined, it will be found that the spawn (*mycelium*) of the fungus has extended from the leaves down the leaf-stalks, even to the blanched portions, and formed on the surface of these innumerable black fruit-conceptacles (see Plate II).

If diseased plants are closely observed after warm, damp, " muggy " weather, the method of the dispersal of the *spores* from the *pycnidia* can easily be seen. Under such conditions it will be found that most of the *pycnidia* have opened, and that the *spores* are oozing out in an agglutinated mucous mass in the form of a little tendril, which is frequently curled round and round (see Fig. 2). This tendril-like mass of *spores* is

whitish in colour, and opalescent, and when in damp weather hundreds of conceptacles close together on a badly infected leaf or leaf-stalk, emit their *spores* in twisting " tendrils," the first general impression of the observer is that there is an infestation of very minute curling " worms " on the surface of the plant. On a closer view, of course—such as may be obtained by the use of a 1s. pocket lens—each " worm " is seen to be a " tendril " of *spores* projecting from the mouth of a *pycnidium*. If a " tendril " is picked off with a needle and laid on a glass slide under the microscope, then on the addition of a drop of water, it will be seen that the *spores* are immediately set free by the dissolving of the mucous substance that kept them together, and now float singly and free in the water. After rain or heavy dew the *spores* are thus carried over the plant, and at once infect new leaves.

In previously published accounts of the life-history in this country of the present fungus it has been stated that the disease occurs comparatively late in the season. Thus Mr. Chittenden concludes his interesting account of Celery " Leaf-spot " in the *Journal of the Royal Horticultural Society*, vol. XXXVII., p. 115, with the remark : " The disease is usually noticed rather late in the season, when it has attained proportions too great for any hope of checking it to be justified, but it seems as a rule to make its appearance somewhat late in the growth of the plants. We have, however, had specimens sent us as early as July." Mr. Massee, also, in the brief account of the disease given in his book on Fungous Diseases, states : " It usually appears when the celery is nearly ready for the market."

As a matter of fact the present disease is usually present on celery plants quite early in the season, and—just as with potato " blight "—if the grower waits until late in the season before taking remedies, the case is hopeless. The erroneous idea of its late appearance on the plant (possibly strengthened by the American name of " Late Blight " for the disease) has probably arisen from the fact that the evident " wilting " and death of the leaves does not take place usually until July, although an examination of the plants in June will generally show the presence of the parasite on many of the leaves.

From certain observations which have been published there was, indeed, every reason to expect outbreaks of the disease quite early in the season. Thus Stevens and Hall, writing of the fungus as it is known in the United States, state in their book "Diseases of Economic Plants,": "The disease is often found in the seed-bed, and is probably carried by the seed, since the *pycnidia* are abundant upon the seeding stalks and fruit." Mr. Chittenden has found that in this country also, the fungus is being distributed with celery seed. He writes (*l.c.*): "Of thirty-three samples of celery seed examined in the laboratory this spring, fourteen showed the *pycnidia* of the fungus upon the seeds or the pieces of stalk mixed with them, and microscopical examination showed these *pycnidia* in the majority of cases to contain *spores* still. Some of these diseased seeds had been grown in England, others on the Continent. At my request, Mr. D. Finlayson, F.L.S., kindly washed several samples of commercial celery seed with distilled water, and microscopical examination of the washings showed the spores of the fungus in fifty per cent. of them. Klebahn has recently shown that washings from seeds saved from diseased plants contain *spores* of the fungus, and by spraying healthy plants with these washings he has infected them with the disease. Indeed, he believes the sowing of seeds containing the *spores* of the fungus is the principal, if not the only, means of distributing the disease."

On examining a bed of seedling celery plants at Wye College during the first week in May, an interesting discovery, of considerable practical importance, was made. It was found that the disease was already present in considerable quantity, in the form of small pale spots on the ternate leaves of the young seedling plants, which were about six weeks old. The diseased spots, which were about 5 mm. in diameter, and which might be passed over as due to some insect attack, bore numerous black *pycnidia*, filled with the ripe *spores* of the *Septoria*. Each spot of diseased leaf-tissue, which was noticeably pale, was permeated by the fungus mycelium, and was dead or dying; these diseased areas extended right through the thickness of the leaf, from the upper to the under surface, as shown in Plates III. and IV., where Plate IV.

represents the same leaf as in Plate III., but turned over to show the lower surface. On both surfaces of the diseased area the *pycnidia* of the fungus occurred plentifully.

A number of different varieties of Celery had been planted out in an open frame, and on May 13th a careful examination was made of all the seedlings; the *Septoria* was found on the following varieties:—Solid White, Clark's Early Market, Superb Pink, Giant Red, and Standard Bearer,—it occurred also on Celeriac. The infestation was decidedly worst on the Solid White seedlings, a very large proportion of the plants having the disease. Some 1911 seeds of Sutton's A1 (plants from which became badly diseased in 1911) and of Sutton's Superb Pink, and also some 1912 seed of Clark's Early Market were examined to see if the fungus were present with the seed, but no trace of it could be found. Unfortunately no seed of Solid White was available for examination. There is, however, the strongest presumptive evidence that these seedlings had become infected from *spores* present with the celery seed that was sown—possibly with the Solid White seed.

The facts reported by others, as noted above, strongly support the supposition, and indeed, it would be almost impossible otherwise to explain the general infestation of these seedlings at the beginning of May.

An experiment was now devised to test the value of spraying in stopping the further spread of the disease. About the middle of May the seedling plants were transferred to trenches in the open ground in the usual way; no discrimination was made, the diseased plants being planted along with the healthy ones in the row. The trenches were 84 feet long, and 2 feet wide, with two rows of plants, 1 foot apart, in the trench. Thus at the time the spraying experiment started a considerable proportion of the plants already bore the disease, so that it was as severe a test of the value of spraying as could be wished for. To make the test as severe as possible, Solid White was chosen for treatment as being the worst affected. One complete row of Solid White was sprayed, while two-thirds of the adjoining row, consisting of exactly similar plants of the same variety from the same bed, were left unsprayed as a "control." The mixture used for

spraying was home-made Bordeaux mixture, prepared as follows :—

Copper sulphate ("bluestone")..	2 lbs.
Quicklime (in lumps)	2 lbs.
Water	25 gallons.

The 2 lbs. of bluestone are dissolved in two gallons of water (this can be done at once with hot water, or in a few hours with cold water if the bluestone is suspended in a piece of sacking). A *wooden* receptacle (pail or tub) must be used. The 2 lbs. of quicklime (freshly burnt, *i.e.*, in lumps) are placed in a tin or wooden pail and slaked by adding water ;—a few pints are first sprinkled over the lumps of quicklime, which cause them to crack and give off steam and finally to crumble down. A little more water must be added as soon as the slaking lime tends to get dry,—in this way after a few minutes a thick creamy paste is obtained. (The operation of slaking lime is hastened if hot water is used ; and if the pail is covered over with a sack.) Now add water to the slaked lime, thereby making "Milk of Lime," until there are two gallons in the pail. Stir and strain through a coarse strainer into a tub holding twenty-one gallons of water. Stir well; the tub will now contain twenty-three gallons of "milk of lime." Now pour in the two gallons of bluestone solution, when a chemical action takes place at once, and Bordeaux mixture is formed. By this method twenty-five gallons of Bordeaux mixture of the best quality are obtained. When made the mixture should be used as soon as possible, as it deteriorates on keeping, and should never be kept longer than forty-eight hours. To obtain the best results only freshly-mixed Bordeaux mixture should be used, and be applied with a nozzle throwing a very fine, "misty" spray, when it will be found that it is remarkably adherent, and it is not washed off foliage for a month or longer. The Bordeaux mixture should be strained through a fine copper gauze strainer.

In our experiments the Vermorel "Eclair" knapsack sprayer was used, with the finest nozzle. The spraying rod was fitted with two adjustable nozzles (as supplied for potato spraying). In spraying celery the best method is as follows :—with the nozzle directed upward spray the underside of the leaves on each side of the row ; then with the

nozzle directed downwards, spray the upper surface of the leaves. Care should be taken to see that the spray gets well into the crown of the plant. When the spray is dry, a bluish deposit is seen over the sprayed parts ; if the spraying is well done, all the fresh growth of the plant is protected by this deposit.

The first spraying of the row of Solid White was given on June 25th, by which time the plants had made a fair growth. On the older leaves of the plants a fair amount of the disease was present ;—the aim of spraying was to cover the fresh growth with the fungicide in order to protect it from infection. One of the effects of this spraying was to kill off rapidly the lower leaves which had been spotted with the disease ; in the adjoining unsprayed " control " row similarly affected leaves died off more gradually under the continued progress of the disease.

On July 17th the dead leaves from both the sprayed and unsprayed rows were removed and burnt. On July 18th, the sprayed row was given a second spraying. At this time the plants in the sprayed row showed on the whole a more vigorous growth in comparison with the unsprayed plants, and their leaves were of a decidedly darker and healthier green.

On August 9th the row of Solid White was given its third and final spraying ; at this date the plants in the sprayed row were conspicuously taller and more vigorous, with much darker green leaves—the difference between the sprayed and unsprayed rows being greater than on July 18th.

On September 14th the difference between the sprayed and unsprayed rows was so great as to strike the eye at a distance (see Plate V.). The sprayed plants were carefully examined, and it was found that through the fresh growth having been unsprayed, the disease was apparent in a few spots on the upper leaves,—though none of the diseased leaves were in any way withered or seriously affected. This slight infestation of the fresh growth of the sprayed row after the last spraying was inevitable under the circumstances, with the adjoining and neighbouring rows of badly infested celery.

By October 11th, when the season's growth had finished, it was seen that the plants in the sprayed row were nearly double the size of the unsprayed plants (see Plate VI.). The tall,

fine plants of the sprayed row seemed none the worse for the slight traces of disease on a few of the leaves, none of which were withered; while the plants in the unsprayed rows were poor and stunted, and had many withered leaves on them.

All the plants in the unsprayed short row, and the same number of plants from the sprayed row, were dug up, and after the removal of the roots, were washed and weighed. The results were as follows:—

Weight of sprayed plants ..	672 lbs.
Weight of unsprayed plants ..	281 lbs.
Increase in weight of plants due to three sprayings with Bordeaux mixture ..	391 lbs.

The plants in the sprayed row were worth from 1s. 3d. to 1s. 6d. per dozen, and were quite up to, if not exceeding, the average for the variety. The plants in the unsprayed rows would not have paid for sending to market; through the ravages of the disease only a very small centre in each could be used, so that the plants were not of sufficient value to be worth the labour of lifting and washing. At the most, the value of the unsprayed plants was 3d. per dozen.

The actual net profit due to the spraying can be estimated as follows. There were 274 plants in the sprayed row. These were worth from 1s. 3d. to 1s. 6d. per dozen, average, 1s. 4½d.; while the plants in the unsprayed row were at the most worth 3d. per dozen., so that the increased value due to spraying was 1s. 1½d. per dozen plants. We have now to deduct the expenses of the treatment. In spraying the 274 plants three times, fifty gallons in all of Bordeaux mixture were used. The cost of this can be put at 1s. 6d. For the labour of mixing, spraying, wear of machine, etc., the sum of 3s. 6d. may be allowed, making the total cost of the treatment 5s. Thus we have:—

	£	s.	d.
Increased value of plants due to spraying:			
Twenty-three dozen plants at 1s. 1½d. per dozen	1	5	10½
Less cost of spraying		5	0
Net profit due to spraying	£1	0	10½

With such a variety as Solid White, when the plants are infested at an early stage with the disease, spraying means (after deducting expenses) an added value of 11d. per dozen plants.

All the other varieties of celery planted out in the experimental vegetable garden at Wye College contracted the disease, the severity of infestation of the various varieties being in the following order:—Solid White (worst of all), Clark's Early Market (nearly as bad), then Superb Pink, Giant Red and Standard Bearer, and Celeriac least of all.

Conclusions.—(1) Although the celery blight disease is usually noticed first in July or later, it is often present on the plant much earlier, and is inflicting serious damage all through the growing period of the plant.

(2) Three sprayings with home-made Bordeaux mixture in June, July and August, will protect celery plants during the growing period from attacks of the celery blight.

(3) In view of the evidence to hand, outbreaks of the disease very early in the season, even in the seed-bed, may be expected to occur. It would probably be a good plan, when the disease is noticed on the seedling plants, to dip them in Bordeaux mixture at the time of transplanting them to the trench.

It may be mentioned that the celery is liable to be attacked by other fungous pests, viz., by *Cercospora* and by *Phoma*.

I wish to acknowledge here the help of my assistant, Mr. H. Wormald, A.R.C.S., B.Sc., in carrying out the experiments and in supplying the photographs shown at Plates II., III., IV. and VI.

SOME SPRAYING EXPERIMENTS AGAINST APPLE SCAB.

With the object of ascertaining the comparative fungicidal values against Apple "scab" of Bordeaux mixture, Lime Sulphur, "Iron Sulphide," and the other washes mentioned below, the following experiments were carried out in the fruit plantations at Wye College.

Bordeaux Mixture.

This was made as follows :—

Copper sulphate ("bluestone")	8 lbs.
Quicklime (in lumps) ..	8 lbs.
Water	100 gallons.

The 8 lbs. quicklime were slaked in a pail by the addition of a little water, in such a way that a thick creamy paste was obtained, a few gallons of water were then added, and the lime was then strained through a fairly fine strainer into a wooden vat, and water added to make ninety-two gallons of "milk of lime." The 8 lbs. copper sulphate dissolved in eight gallons of water (in a wooden receptable) were then poured in, and the Bordeaux mixture resulting, after being strained into the spraying machine through a very fine copper gauze strainer, was used the same day.*

On June 6th eighteen trees of Bismarck were sprayed with the above, an extremely fine spray being applied, which when dried, coveréd the leaves uniformly with the bluish-grey deposit—giving the foliage at first sight much the appearance of being affected with "silver-leaf." There were nine "control" trees. At the time of spraying a few of the leaves had small spots of "scab" on them.

On June 15th the trees were examined and the following

* An equally satisfactory method of making Bordeaux Mixture from *stock solutions* of lime and copper sulphate is described in a leaflet obtainable on application to the Secretary.

facts were noted :—(1) the "scab" spots were now brown, due not only to the "scab" fungus (*Fusicladium*) having been killed, but also to the fact that at each spot where "scab" had been (but not elsewhere) the spray had killed the underlying leaf-cells—the dead patches of cells extending from one surface of the leaf to the other. These dead areas were not large or numerous enough to cause any serious injury to the leaves. (2) The hairs on the under-surface of the sprayed leaves were turned yellow, the whole under-surface being noticeably yellowed on comparing it with unsprayed leaves—no injury to the leaves resulted from this.

On June 21st the spray still covered uniformly the leaves, although very heavy rains had occurred between June 15th and June 21st. It was quite clear that all the spots of "scab" had been completely killed, and that no fresh infections had taken place. One of the "control" trees showed numerous actively growing patches of "scab" on the leaves.

On July 17th the foliage of the sprayed trees was still perfectly well protected by the spray, and attacks of "scab" had been prevented. No "scorching" of the leaves, nor leaf-fall had occurred; the apples were slightly spotted or blotched through the action of the spray—the effect being the production of purplish marks on the skin. This was not serious enough to affect the market value of the fruit. Several of the "control" trees bore leaves quite "sooty" from the infestation of "scab."

No further development of "scab" took place either on the sprayed or "control" trees.

Conclusions.

Home-made Bordeaux mixture kills "scab" on the leaves of Bismarck, without causing any general injury to the foliage in the form of "scorching" or leaf-fall. If the spray used is very fine and "misty," and the spraying done carefully, one application will kill all "scab" spots that are present and protect the trees from further infection *for six weeks afterwards*. The injury caused by the death of the leaf-tissue at the places where "scab" existed must not be confused with "scorching" proper; the former injury is strictly local and not serious if the "scab" spots are small and few;

badly "scabbed" leaves, of course, will be seriously injured through large areas of the leaf-tissue being killed, and there is no doubt that such injury has been confused by growers with spray injury proper.

On June 7th ten trees of Worcester Pearmain were sprayed in the same way as above. There were six "control" trees.

On June 15th it was noted that the under-surface of the sprayed leaves had turned to an evident yellow colour—this was most evident on the younger leaves where there were more hairs; no injury resulted from this yellowing.

On June 21st the sprayed foliage was free from "scab"; no "scorching" nor leaf-fall had resulted. The "control" trees also were free from "scab."

On July 17th the sprayed foliage was very healthy, and no injury whatever had been produced by the spray. A little "scab" was present here and there on the leaves of the new shoots of both the sprayed and unsprayed trees. The fruit was uniformly clean; occasionally with a few small purplish spots due to the action of the spray, though the great majority was quite unaffected by the spray. The "scab" later died away on the new shoots of both sprayed and unsprayed trees.

Conclusions.

Home-made Bordeaux mixture is safe to use on Worcester Pearmain.

On June 10th five trees of Ecklinville were sprayed in the same way as the above. There were three "control" trees.

On June 15th a yellowing of the under-surface of the leaves was visible, but no "scorching" nor other injury resulted.

On June 21st the sprayed foliage was free from "scab"; no injury from the spray. The "control" trees were also free from "scab."

On July 17th the sprayed foliage was still well covered by the spray and free from "scab." No "scab" on the "control" trees.

Conclusions.

Home-made Bordeaux mixture is safe to use on Ecklinville.

On June 10th eight trees of Wellington were sprayed in the same way as above. There were eight "control" trees.

On June 15th a yellow colour was apparent on the under-surface of the leaves—this was very noticeably the case with many of the younger leaves, which were very yellow, but no injury resulted.

On June 21st the sprayed foliage was free from "scab"; no "scorching" nor other injury occurred. The "control" trees also were free from "scab."

On July 17th the sprayed foliage was still well covered with the spray and quite free from "scab"; the "controls" were also healthy.

Conclusions.

Home-made Bordeaux mixture is safe to use on Wellington.

On June 10th six trees of Warner's King were sprayed in the same way as above. There were five "control" trees. Many of the leaves had spots of "scab" on them at the time of spraying.

On June 15th the sprayed leaves were very noticeably yellowed on the under-surface, but no injury resulted. The "scab" spots were still visible through the spray deposit, and had not yet, apparently, been killed.

On June 21st the "scab" spots were still not dead, but were not spreading. "Control" trees showed a good deal of "scab."

On July 17th the sprayed foliage was still well covered with the spray. The "scab" had died both on the sprayed and unsprayed trees. A few purplish marks were evident on the fruit, but the injury was not enough to affect their quality.

Conclusions.

Home-made Bordeaux mixture is safe to use on Warner's King.

The Woburn Bordeaux Paste.

The spray was prepared by dissolving 8 lbs. of the paste in 100 gallons of water, according to the directions sent out by the makers.

On June 10th eighteen trees of Bismarck were sprayed, using the fine spray as described above. There were nine "control" trees.

On June 15th many of the " scab " spots, which had been present on the leaves at the time of spraying, were killed, together with small patches of the leaf-tissue underlying them. The under-surface of the leaves was yellowed, but no injury resulted from this.

On June 21st it was clear that most of the " scab " had been killed, but on some leaves the " scab " fungus could be seen growing again at the edge of the original spots which had been partly killed.

On July 17th there was a certain amount of " scab " on the sprayed leaves. Many of the sprayed apples had the same small purplish spots on the skin as was produced by the home-made Bordeaux mixture.

Conclusion.

One spraying of the Bordeaux paste was not so effective against " scab " as home-made Bordeaux mixture.

On June 7th ten trees of Worcester Pearmain were sprayed in the same way as above. There were six " control " trees.

On June 15th the deposit from the spray was scarcely visible on the sprayed leaves. The under-surface of the leaves was yellowed, but no injury resulted.

On June 21st no visible trace of the spray remained.

On July 17th no " scab " was present on the leaves of either the sprayed or " control " trees. As with home-made Bordeaux mixture, the spray had caused small purplish spots on some of the apples.

Conclusion.

The fungicidal value of the spray could not be tested under the conditions.

Lime-Sulphur.

The wash* was prepared in a concentrated form as described in this *Journal*, Vol. XX., p. 415, and was then diluted and used at a concentration of 1.01 *sp. gr.*

On June 6th eighteen trees of Bismarck were sprayed, the wash being applied with the same nozzle giving the extremely

* A leaflet giving information on the making of the Lime-Sulphur wash can be obtained on application to the Secretary.

fine spray as described above. The leaves of the trees were almost uniformly covered over with the whitish deposit from the dried spray. There were nine " control " trees.

On June 15th the few spots of " scab " which were present on the leaves at the time of spraying were all, or nearly all, killed, and also—just as in the case of leaves sprayed with Bordeaux mixture—the portion of leaf-tissue where the " scab " fungus had been was killed also and turned brown. Besides this, there were other small brown spots on the surface of some of the leaves, and spots or patches of dead leaf-tissue at the margin of several leaves, due to the " scorching " action of the spray. Some amount of yellowing of the under-surface of the leaves was evident, but this was not nearly so marked as in the case of the trees sprayed with Bordeaux mixture. There was also a quite noticeable leaf-fall caused by the action of the spray.

On June 21st the dried spray still covered very satisfactorily the leaves and apples; a little " scab " was still visible growing on some of the sprayed leaves; there were either fresh infections or some of the original spots of " scab " which had not been completely killed, were now growing vigorously again. A new effect was now evident; although no more leaves, or only a few more, had fallen, some of the apples had fallen off (on the sprayed trees only), due to spray injury caused apparently to the stalk of the apple.

On July 17th the spray was still visible on the leaves and fruit, and both were now free from " scab " (although " scab " was present on the leaves of the " summer shoots " which had appeared subsequently). Scab was quite bad on some of the leaves of the unsprayed " control " trees at this date. After July 17th the " scab " died away on both the sprayed and unsprayed trees. There was no injury in the form of purplish spots on the skin of the apples, nor any other kind of injury, and there was no further fall of leaves or fruit, which altogether was not serious enough to cause appreciable injury.

Conclusion.

It appears safe to draw the following conclusions :—
(1) Lime-Sulphur is a fungicide sufficiently powerful to stop *slight* attacks of " scab." This is the conclusion arrived at

by experimenters in the United States. (See this *Journal*, Vol. XIX., p. 336.) (2) The spray, while harmless to the skin of the apple, may damage the stalk and cause some of the fruit to fall. (3) The strength 1.01 *sp. gr.* is near danger-point, both as regards injury to leaves and fruit.

On June 6th ten trees of Worcester Pearmain were sprayed in the same way as above. There were six "control" trees.

On June 15th the sprayed trees showed a noticeable leaf-fall, and a trace of "scorching" on some of the leaves on the trees; there was slight yellowing of the under-surface of some leaves.

On June 21st and July 17th no "scab" was visible on the sprayed or "control" trees; no further leaf-fall nor "scorching" occurred.

Conclusion.

Lime-Sulphur at 1.01 *sp gr.*, applied at the beginning of June, caused no appreciable injury to Worcesters.

On June 11th five trees of Ecklinville were sprayed as above. There were three "control" trees.

On June 15th yellowing of the under-surface of the leaves was apparent; no injury in the form of leaf-fall or "scorching" occurred.

On June 21st the little "scab" that had been present on the the fruit at the time of spraying was increasing.

On July 17th the "scab" had developed further on the fruit.

Conclusion.

Lime-Sulphur at 1.01 *sp. gr.* causes no injury whatever to Ecklinville.

On June 10th nine trees of Duchess' Favourite were sprayed as above. A very slight amount of "scab" was present on the leaves. There were eight "control" trees.

On June 15th the trees showed no "scorching" nor leaf-fall.

On June 21st an appreciable leaf-fall, and also a fall of many young apples, had taken place.

On July 17th no further injury had resulted.

Conclusion.

Lime-Sulphur at 1.01 *sp. gr.* may cause appreciable injury, and 1.005 *sp. gr.* should be tried. (Bordeaux mixture must not be used with Duchess' Favourite (see this *Journal*, Vol. XX. p. 409).)

"Self-boiled" Lime-Sulphur and Iron Sulphide Wash.

This wash was prepared as follows:—8 lbs. of quicklime were placed in a 50 gallon barrel, and two or three gallons of boiling water were poured over it. Then 8 lbs. of "flowers of sulphur" (after being run through a fine sieve in order to break up any lumps) were stirred into the slaking lime, and a bucket of hot water added.

The mixture was stirred occasionally in order to prevent caking. The barrel was covered over with sacking so as to retain the heat given out by the slaking lime, which causes the mixture to boil for ten to twenty minutes—according to the quality of the lime. During this boiling a small amount of sulphur goes into solution. As soon as the lime is slaked—that is, as soon as the boiling has ceased—cold water is added up to the 40-gallon mark, in order to prevent more sulphur going into solution. The mixture is strained through a sieve of twenty meshes to the inch, in order to remove the coarse particles of lime, but all the sulphur is worked through the strainer. Ten gallons of water in which 3 lbs. of iron sulphate have been dissolved are then added. The mixture, on being stirred, turns inky black; on drying on the tree it turns dark slate colour. In a few days this oxidizes to a reddish-brown colour, which remains constant.

On June 10th six trees of Warner's King were sprayed in the same way as in the previous experiments. There were five "control" trees. Many of the leaves at the time of spraying bore numerous patches of "scab."

On June 15th the dried spray appeared as a very thick wash well spread over the leaf surface. The under-surface of the leaves was distinctly yellowed; no leaf-fall nor injury of any kind resulted. All the "scab" spots were killed, and there were little dead patches of leaf tissue at the same places extending through the thickness of the leaf.

On June 21st the spray deposit still covered the leaves uniformly; no fresh attack of "scab" had occurred.

On July 17th the spray was still remarkably adherent and uniform. It was clear that the original attack of "scab" had been completely stopped from developing. No injury was produced to leaves or fruit.

Conclusion.

The spray is remarkably adherent, and stops satisfactorily an attack of "scab," without causing any injury to leaves or fruit. This spray—with perhaps some modification in its making so as to ensure its composition being more uniform—shows distinct promise and is worthy of an extended trial.

"Self-boiled" Lime-Sulphur and Copper Sulphide Wash.

This wash is made like the preceding wash, except that in the place of the iron sulphate, 2 lbs. of copper sulphate dissolved in 10 gallons of water are added.

On June 10th six trees of Warner's King were sprayed i the same way as above. There were five "control" trees.

On June 15th the sprayed leaves were well covered over with the deposit from the spray. The under-surface of the leaves was very evidently yellowed. No injury resulted. Many of the "scab" spots (present at the time of spraying) were killed, with dead patches of leaf tissue as in the above experiment.

On July 17th the leaves were still well covered, and had been protected from further attacks of "scab." No injury resulted to foliage or fruit. On the "controls" "scab" was present on leaves and fruit.

Conclusion.

This spray is equally worthy of further trial.

THE AMERICAN GOOSEBERRY MILDEW.

(*Sphaerotheca mors-uvae* (Schwein.) Berk.)

The present state of affairs with regard to the spread of the American Gooseberry Mildew in Kent is shown in the following account, prepared from the Reports made by Mr. R. S. Vinson, the Inspector appointed by the Kent County Council under the "Destructive Insects and Pests Act, 1907."

In 1912 the mildew in its "summer-stage" was first found in the county on April 29th, in the Sandwich and Maidstone Districts, and quickly began to appear in a number of plantations. The fruit was attacked more or less in a large number of plantations, and in some cases was very bad. Growers were required to sort out and destroy all diseased berries before sending fruit to market. This requires great care on the part of the pickers and packers, and a number of cases have occurred where consignments containing diseased fruit were sent to market. The season of 1912 appeared to be very favourable to the mildew, which spread rapidly before and during July. As a consequence growers were advised to start cutting out and destroying all infected shoots as early as possible, as a protection to next year's crop.

In July, 1912, the amount of disease in each district, as compared with 1911, was as follows :—

Swanley District :—

Year.	No. of Plantations Diseased.	Acres.	Plantations where Disease on Fruit.
1911	118 Plantations=	485	49 Plantations.
1912	180 Plantations=	720	83 Plantations.

The disease was rather late in appearing in this district, and did not attack the fruit very seriously. There were, it is

believed, only three or four cases where more than one or two halves of diseased berries have been found, in many cases only a few berries being diseased. There have been seventeen new outbreaks scheduled in this district, these amounting to twenty-five acres.

Maidstone District :—

Year.	No. of Plantations Diseased.	Acres.	Plantations where Disease on Fruit.
1911	95 Plantations=	331	53 Plantations.
1912	230 Plantations=	761	107 Plantations.

In this district disease was first found on April 29th, 230 cases being found up to July 6th. Of these, disease attacked the fruit in 107 cases; but in most cases diseased berries were few. There have been thirteen new outbreaks scheduled in this dictrict.

Sandwich District :—

Year.	No. of Plantations Diseased.	Acres.	Plantations where Disease on Fruit.
1911	31 Plantations=	49	9 Plantations.
1912	200 Plantations=	292	135 Plantations.

This district has been badly attacked this year, and there have been a number of plantations where the fruit has been very badly diseased. In some cases growers have grubbed the bushes. Disease started early, and quickly became bad. There have been thirty-seven new outbreaks scheduled, *i.e.*, thirty-nine acres. In this district there is one case of Red Currants being badly diseased.

The Report presented later was as follows :—

Swanley District :—

In October, 1912, the acreage of infested plantations, as compared with previous years, was as follows :—

Year.	Bad, *i.e.* above 40 per cent. of bushes affected.	General, *i.e.* between 40-15 per cent. affected.	Slight, *i.e.* less than 15 per cent. affected.	Few, *i.e.* from 1-10 bushes affected.	Total.
	Acres.	Acres.	Acres.	Acres.	Acres.
1908	393	231	378	252	1234
1909	122	84	250	431	887
1910	279½	208½	635	263½	1387
1911	162	63	405	445	1073
1912	228	200	335	534	1297

There are 86 acres newly infected, and 154 acres free last year but infected previously and again infected this year. With reference to the above table, attention should be called to the fact that of the total of 1,297 acres infected, 889 acres are only slightly or very slightly diseased, and the only measures necessary are to tip the suckers and any suspected shoots. This large slightly infected acreage makes the total look rather big, but in many of the cases only a person constantly searching for disease would be able to find it. The same holds good for the "slight" and "very slight" acreage in the Maidstone and Sandwich Districts.

The summer-stage was first found on May 2nd, in two cases, and gradually became general. The cases recorded each month were as follows :—

May	62	cases.
June	93	,,
July	159	,,
August	71	,,
September	45	,,
October	7	,,

Maidstone District :—

In October, 1912, the acreage of infested plantations, as compared with previous years, was as follows :—

Year.	Bad.	General.	Slight.	Very Slight.	Total.
	Acres.	Acres.	Acres.	Acres.	Acres.
1908	225	149	330	316	920
1909	130	65	148	145	488
1910	222	247	462	295	1226
1911	171	223	474	259	1127
1912	152	394	529	397	1472

There are 185 acres newly infected, including old plantations that were freed last year, and which became re-infected again this year. The majority of these are very slightly diseased.

The summer-stage first appeared on April 29th, and the following cases were recorded each month :—

April	2	cases.
May	67	,,
June	116	,,
July	186	,,
August	96	,,
September	41	,,
October	5	,,

Sandwich District :—

In October, 1912, the acreage of infested plantations, as compared with previous years, was as follows :—

Total.	Bad.	General.	Slight.	Very Slight.	Total.
	Acres.	Acres.	Acres.	Acres.	Acres.
1909	—	5½	4	2½	12
1910	9½	65½	167¼	7¼	249½
1911	25	39½	137¼	94¾	296½
1912	92¼	114½	100	100¼	407

There are 100 acres newly infected this year, and ten acres which were freed last year are now re-infected.

The "summer stage" appeared first on April 29th. The cases recorded each month were as follows :—

April	13 cases.
May	80 ,,
June	103 ,,
July	74 ,,
August	28 ,,
September	9 ,,

The Report presented on January 14th, 1913, was as follows :—

Swanley District :—

Twenty-three more outbreaks have been discovered, bringing the infected acreage up to 1,344 acres.

Infected Acreage	1,344 acres (460 plantations).
Of which Grubbed	50 acres.
	1,294 acres.

Of these 1,294 acres to be dealt with by pruning, 568 acres (244 plantations) have been pruned to the satisfaction of the Inspector and "passed."

Of the remaining 726 acres, in 587½ acres the bushes have been tipped to a greater or less degree in order to remove mildew—or pruning is now in progress. They are, however, not yet sufficiently well done to be "passed." In 138½ acres, nothing has been done. It is understood that about 20 acres of this will be grubbed.

Maidstone District :—

Forty-nine cases of disease have been found, bringing the infected acreage up to 1,565 acres.

Infected Acreage	1,565 acres (562 plantations).
Of which Grubbed	34 acres.
	1,531 acres.

Of these 1,531 acres to be pruned, 778 acres (309 plantations) have been pruned to the satisfaction of the Inspector and "passed."

Of the remaining 753 acres, in 723 acres the bushes have been tipped over to remove disease, but were not sufficiently well done to be "passed." In 30 acres nothing has been done.

Sandwich District:—

Twenty-two more cases have been found, bringing the infected acreage up to 444 acres.

Infected Acreage	444 acres (329 plantations).
Of which Grubbed	15 acres.
	429 acres.

Of these 429 acres to be pruned, 153 acres (135 plantations) have been done to the Inspector's satisfaction, and "passed," and 276 acres are not yet fit to pass, though in most cases a lot of tipping has been done.

In April, 1913, the Inspector's final Report for the acreage of infected plantations on which the winter stage of the mildew was found during the winter 1912-13 was as follows:—

Swanley District:—

Infected acreage	1,350	acres.
Free acreage	411	,,
Grubbed	69	,,

Maidstone District:—

Infected acreage	1,502	acres.
Free acreage	1,000	,,
Grubbed	52	,,

Sandwich District:—

Infected acreage	442¾	acres.
Free acreage	50	,,
Grubbed	36¼	,,

The above Reports show a very serious state of affairs. It is quite obvious that the compulsory measures as at present carried out do not in any way check the spread of American Gooseberry-Mildew to fresh plantations. As far back as 1910

the Committee of the Kent County Council reported as follows :—

" The Reports of the Inspectors with regard to the disease are very discouraging. The reappearance of mildew in those plantations in which it was supposed to have been eradicated by the vigorous measures of pruning and spraying which were adopted is an especially discouraging fact, which raises a doubt whether these remedies will ever be really effective in stamping out the disease. Climatic conditions in 1910 have no doubt contributed to the spread of the disease, but unless the remedies adopted are such as will be effective, whatever the weather may be, the question arises whether the money which is being spent in the enforcement of these Orders, is not being wasted. For three years the Council's Inspectors have been carrying out with zeal and care the requirements of the Board of Agriculture, with the disappointing result that the disease now affects a much larger area than it did in 1908. Growers have, with rare exceptions, readily done all they have been called upon to do, and some 220 acres have been entirely grubbed. Your Committee think that the time has come when the Board of Agriculture should be asked to consider the position, and they propose to ask the Board to receive a deputation which will place before them the results of our attempts to deal with this disease."

Now the position of affairs as regards the infested acreage in comparison with last year is as follows :—

	1911-12.	1912-13.
Swanley District ..	1,168	1,350
Maidstone District ..	1,077	1,502
Sandwich District ..	316	442
	2,561	3,294

So that we have now in Kent, with which to start the season of 1913, no less than 3,294 acres of mildewed plantations after the county has been carrying out for five years the Board of Agriculture's " American Gooseberry Mildew Orders." The present compulsory measures, presumably decided upon by the Board of Agriculture's scientific adviser, are either

faulty, or they are not being properly enforced. In my last Report I wrote:

"Whether the measures decided upon by the Board of Agriculture to combat this new pest are, scientifically considered, wise or not, it is not for us to criticize here. It is obvious, however, that all gooseberry growers should, in their own interests, co-ope ate to carry out in a determined manner the measures officially decided upon, so as to give these measures every chance of success, since the Board of Agriculture believes that they are sufficient to save the crop of gooseberries without inflicting too heavy an expense on the grower. The success of the measures depends on the *early autumn* pruning of the diseased bushes; yet we find that on January 9th, 1911, no less than 860 acres out of the total affected area of 2,536 acres still remained unpruned. All through the winter months the 'fruit conceptacles' (*perithecia*), containing the '*winter spores*' of the mildew, continue to drop from the affected shoots and infect the soil; when this has taken place the good that results from the removal of the diseased shoots is to a large extent nullified.

"At the risk of giving offence, it becomes a duty to point out that 'legislative measures' against plant diseases must be in their essence compulsory. These special measures are either worth enforcing systematically and without exception throughout Kent, or they are not; they represent presumably the scientific opinions of the present advisers at the Board on fungous diseases, and the responsibility rests with them.

"Where the winter pruning is delayed far into the winter the soil under the bushes is practically certain to become infested, with the result that the work and expense of pruning these plantations are to a large extent wasted. Further, diseased plantations that have not been pruned by the end of the year must be regarded as a menace to the whole neighbourhood; outbreaks of the mildew will in all probability—owing to the soil infestation—appear early in May, and start the disease for the season. Under suitable weather conditions, the mildew will spread rapidly by means of its 'summer stage' and put the crop of berries in jeopardy—as occurred in several places in Kent last season.

"In my opinion, it is absolutely necessary—in order to

give the existing measures an opportunity of showing to what extent they can control the American Gooseberry-mildew—*that the autumn pruning of diseased bushes is uniformly enforced over the whole of Kent.*"

This year the state of things is even more unsatisfactory. The total affected acreage is considerably more, and the proportion where the autumn pruning of affected shoots as directed by the Board's Orders has *not* been carried out is considerably larger, for on January 14th last no less than 1,586 acres (or nearly one half of the total affected area), which should have been pruned by October 31st, were still unfinished.

So that, unsatisfactory as the position was in 1911-12, it is decidedly worse in 1912-13. Speaking at the Annual Meeting of the Fruit-growers' Federation in London, on February 19th last, I pointed out that, assuming that the measures officially decided upon are satisfactory, the failure to enforce them during the past few years has made the work in connection with the Board's "American Gooseberry-Mildew Orders" a waste of public money.

Owing to the slackness in enforcing autumn or early winter pruning, and the consequent regular reappearance of the mildew in the plantations, fruit-growers are losing all faith in the value of any winter treatment. The Maidstone Farmer's Club have recently passed the following resolution : "That this Club and Chamber respectfully urge upon the Board of Agriculture that in view of the experience of practical fruit growers, that tipping gooseberry bushes has been proved to be useless in the prevention of gooseberry mildew, and that the pest can only be dealt with by spraying, the regulations should be modified so as to omit compulsory tipping, and the Club and Chamber would support a more drastic application of the regulations as regards spraying." This resolution was debated at the Canterbury Farmers' Club on March 14th last, and the following account of the opinions then expressed by fruit-growers and others is taken from the *Kentish Observer* of March 20th, 1913.

"Mr. Champion, Secretary of the Maidstone Farmers' Club, attended the meeting and said he was present that evening to try to enlist the Canterbury Club's sympathy in that matter. The Maidstone Club, he said, were engineering

a conference with the Board of Agriculture and he was going to ask the Canterbury Farmers' Club to appoint two members to go with delegates from Maidstone and the Dartford Fruit-growers' Association to try and thrash that matter out. Three or four years ago he had the honour to attend in that room to try to induce the Board of Agriculture to take the action they were now taking. A good deal of water had run under the bridges since then and the action the Board of Agriculture was now taking they considered too late. The County Council had up to now managed the inspectors and the work they had done had been in looking after fruit-growers in order to try and do away with and destroy gooseberry mildew. The Board of Agriculture now said to the County Council, 'You have not done the work very well, and you ought to have summoned the farmers.' He believed some fifteen or twenty summonses had been just hanging in the balance as to whether they should be served on some of the largest farmers or not for not doing their duty, and the Board of Agriculture were asking the county to transfer the overseeing from the County Council to the Board of Agriculture. They had been compelled by the inspectors to tip their gooseberry bushes, but he had no hesitation in saying that tipping was an invitation to the disease the following year. Tipping resulted in doing away with the crop and the next year they had trees full of undergrown wood, which was just the stuff to catch it. Instead of ten or fifteen tips they had nearly a hundred, with the result they were bound to have the disease the next year. He had no fault to find with the inspectors. They had almost an impossible task given to them and he was sure they had done their duty as well as they could. Red spider was very common in his part of the world, and they had learned to wash with liver of sulphur at the beginning of March, and spraying the trees five or six times before they got much foliage, and where they had had it worst there was no gooseberry mildew. They considered the cure for red spider was also the cure for gooseberry mildew. They had carried out other experiments and were sure that if spraying would not cure it it would keep it in check. In his district they felt that tipping was no good, in fact, worse than useless, for it robbed them of fruit, and they were worse off another year, and as the Board of Agriculture

said they were now going to make their regulations more stringent they felt the time had arrived to take action to try to prevent that coming about.

"Mr. E. S. Salmon, of Wye College, said :—' With regard to this resolution sent from the Maidstone Farmers' Club I am not in sympathy with it for two reasons. The first reason is this, in order to keep down American Gooseberry-Mildew there will always have to be some measures taken in winter, *viz.*, the removal of the shoots which bear the winter stage of the mildew. I must point out here that Mr. Alfred Amos is wrong in supposing that the Hop Mildew and the American Gooseberry Mildew are exactly similar diseases that can be treated by the same measures. In the case of the hop mildew the winter stage is formed on parts of the plants, *viz.*, on the leaves and hops, which die away, so that the hop plant starts free from mildew each season. In the case of the gooseberry, a bush once affected has the mildew in some stage always upon it, so that unless measures are taken in winter, the bush starts each season covered more or less with mildew. If the diseased shoots were not cut off and destroyed, the primary sources of infection are much more numerous in the spring, with the result that young green berries would be attacked generally in the majority of plantations.

" 'The following information—supplied by the Board of Agriculture—is very instructive as showing what actually occurred in a case where the winter pruning and destruction of affected shoots was to a certain extent neglected. In a certain district, in a certain county, the local authority refused to take action, with the result that the growers, being left pretty much to themselves early in the season, carried out no systematic pruning measures, though later the growers were forced to prune to a certain extent. In this district there were 128 cases of outbreaks of the mildew in 1909-10 ; as the result of the growers neglecting to carry out proper winter pruning of the diseased shoots there were no less than sixty cases in this district in 1910 in which the berries were attacked.

" 'Pruning will not be done in many instances unless it is made compulsory, *i.e.*, unless growers who fail to do it are fined. The second reason is this : no perfectly satisfactory summer spray is yet known able to be used on all varieties of

gooseberries without causing the leaves to fall off, or without covering the berries with a deposit that makes them unsaleable. Further, I cannot believe that the mover of the resolution believes in his heart that compulsory summer spraying of gooseberries could at the present time be enforced in every affected plantation in this county, to say nothing of more backward places. I certainly do consider that inspectors should order compulsory summer spraying in some cases, *viz.*, in those cases where an infected plantation becomes a source of danger to the neighbourhood.

" 'There are one or two further observations I should like to make. I should like to say that my sincere sympathies are with fruit-growers in their present difficulties. In the matter of the American Gooseberry Mildew fruit-growers have been very badly treated by the Board of Agriculture in the past, but there is no good whatever in dwelling upon that; the wise course is to see that the fruit-growing industry is treated better in the future, not only with regard to this gooseberry mildew, but as regards the legislative control of other similar plant diseases.

" 'Now with regard to this "tipping" in winter, these are the measures which the Board, following presumably the advice of their scientific expert at Kew, stated at the time of the introduction of the mildew would control this new pest. At the time I stated that in my opinion this advice was scientifically at fault. But since the decision was finally made by the Board I have endeavoured by all means in my power to persuade growers to carry out the Board's measures to the letter in the hope that the mildew would be controlled. Since I was unable to get the authorities to adopt the measures which I considered necessary to stop the spread of the mildew, I have been experimenting with summer sprays, chiefly the lime-sulphur spray. The results of some experiments carried out last season, and recorded in this month's *Journal of the Board of Agriculture*,* show that with some varieties of gooseberries the lime-sulphur spray can safely be used, and that six sprayings will prevent bushes from being infected and the consequent formation of the winter stage on their shoots. This treatment is not applicable, however,

* Reprinted below, at p. 394.

to all varieties of gooseberries, and it interferes with the marketing of the berries.

"'The present system of inspection is faulty, and the permit allowing bushes to be removed from infected areas is thoroughly unsatisfactory. Let me just mention a recent case showing how the disease is still being sent about the country. For experimental purposes we are planting plots of different varieties of gooseberries at our new fruit station at East Malling. We obtained some bushes of "Yellow Rough" from a certain nursery (not in Kent); they arrived at East Malling, were found to be quite severely infested on the shoots, and were promptly burnt. On enquiry it was found that the bushes had been obtained by the nurseryman from the Midlands.

"'Finally, may I suggest that fruit-growers should look to the future more. At the present time, after agitating since 1905, we have a Horticultural Department at the Board. But at present it exists only in name. In the past the Board have been endeavouring to carry out measures against plant diseases which require constant advice from horticultural, mycological and entomological experts without having had the services of such a staff. The fruit-growing industry of England, rapidly growing as it is, demands better attention than this.'

"Mr. Spencer Mount considered that before asking the Board of Agriculture to alter their regulations growers ought to have one more season's experience of tipping and spraying. In his own case he had all of his bushes tipped, but he was rather sorry he had after hearing Mr. Champion's reasons against it. He did not think the Board of Agriculture would do away with compulsory tipping because their inspectors had had cases where they had found that where tipping had been done properly it had done away with mildew, but whether the Board recognised the harmful effects in there being so much young growth the following year he could not say. As regards compulsory spraying they had not at present a safe wash to use in summer to do any good, because if they used liver of sulphur it was washed off with the first rain that came, and in a showery year continuous spraying was necessary. Lime sulphur wash was only in an experimental stage and unless

used very carefully it did more harm than good in fetching the leaves off.

"Mr. Alfred Amos said they knew the effect of sulphur on mould in hops, and he could not see why it should not have the same effect on gooseberry mildew. He should like to know whether experiments had been made with dry sulphur on the gooseberry. He should like to know who advised tipping to the Board of Agriculture, and also when the bushes were tipped whether the tips were allowed to drop on the ground, because if that was done they might just as well not tip the bushes. He could not see why there should not be compulsory spraying in the same way as there was compulsory sheep dipping, which was no hardship on anybody.

"Mr. J. D. Maxted said, as a member of the Kent County Council who had to look after the carrying out of the inspection for gooseberry mildew, he should like to explain for his own sake and the sake of those members of the committee who were not present the action taken by the committee. They were all aware that when they started in that matter it was rather a difficult task, because they had to tackle a subject that little was known about. They felt they should have to go rather gingerly. With regard to the statement that the Board of Agriculture talked of taking the powers from the County Council that information was not known by the committee of the County Council. The County Council had acted in rather a persuasive way than in too obnoxious a manner in order to gain the sympathy and co-operation of gooseberry-growers in stamping out and in checking the disease. The committee were very anxious not to have to compel growers to carry out the work by prosecution if possible, and that was the reason why they had not moved faster.

"The Chairman raised the question whether the inspectors might not carry the disease from one plantation to another supposing they did not take every precaution to disinfect their boots, etc.

"Mr. Salmon replied to the points raised, in the course of his remarks stating that the inspectors of the Board of Agriculture and the county inspectors took all reasonable precaution. The county inspectors had had a difficult job, but

he thought they had carried it out as well as they possibly could.

"Mr. Champion wound up the debate, and on the proposition of Mr. Geoffrey Neame, seconded by Mr. A. Collard, the matter was deferred till the next meeting."

Reverting to the Inspector's reports given at the commencement of this article, it is to be noted that the mildew appeared earlier in the year 1912 than in 1911, and that in 1912 a far greater number of cases occurred where the berries were attacked—in some cases they were rendered unsaleable. Both these occurrences may be attributed to the neglect shown in 1911 in destroying the diseased shoots in the autumn. On January 11th, 1912, no less than 860 acres, out of the total affected area of 2,536, still remained unpruned.

As the American Gooseberry Mildew becomes more and more firmly established in this country, it is to be expected that early outbreaks of the "summer-stage" will occur, and that the infestation of the berries will become more and more pronounced. In such cases some amount of summer spraying will be absolutely necessary. In an article given below* it is pointed out that the Lime-sulphur spray can safely be used on certain varieties of gooseberries. In this way early outbreaks can be dealt with. As, however, the deposit caused by this spray renders the berries unsaleable, the spraying must be discontinued where the berries are to be marketed green. During this period, freshly-prepared liver of sulphur solution at the rate of 1 oz. to 3 gallons of water should be used. Where the berries are to be marketed ripe, two or more sprayings with Lime-sulphur may be given. It will probably be found in the case of some varieties that the berry itself will become at a certain stage of growth immune to the mildew. Later sprayings with Lime-sulphur will prevent the shoots from becoming attacked.

It is to be noted that the Board of Agriculture, under the powers given them by the "Destructive Insects and Pests Act, 1907," have issued a new Order employing legislation in a new direction. This Order, which came into force on April 1st, 1912, is entitled the "American Gooseberry Mildew (Fruit) Order, 1912," and contains the following provisions :—

* See page 394.

(1) *Prohibition of Sale.*—The sale or exposure for sale of mildewed gooseberries is hereby prohibited, and any person who knowingly sells or exposes for sale mildewed gooseberries shall be liable on conviction to a penalty not exceeding £10.

(2) *Regulation of Importation.*—(*a*) The landing in England or Wales of any gooseberries brought from any place outside Great Britain (except the Channel Islands) is prohibited, except where there is attached to the package in which the fruit is imported a label bearing the words "Imported Gooseberries" and stating the name of the consignor and the country and district in which the fruit was produced.

(*b*) The label shall not be erased or obliterated or detached from the package so long as any of the imported gooseberries remain therein.

(3) *Information as to Imported Gooseberries.*—Every person who has or has had in his possession any imported gooseberries, and every person who as auctioneer, salesman or otherwise has sold or offered for sale any imported gooseberries, shall if so required give all such information as he possesses as to the county and district in which the fruit was produced, and the consignor by whom, and the consignee to whom, the fruit was consigned.

(4) *Cleansing Packages.*—A package which has contained mildewed gooseberries shall, on the removal of all gooseberries therefrom, and before the package is again used for packing gooseberries or any other description of fruit, be thoroughly cleansed by washing or other suitable method by the owner or other person in charge of the package.

THE *RHIZOPUS*-ROT OF TOMATOES.

In May, 1912, Mr. Walter Voss sent to the College for investigation a box of tomatoes, many of which were found to be in an advanced stage of putrefaction. In a subsequent communication the following information was supplied: "The trouble does not show itself at the time of shipment, but on arrival here a certain proportion of the fruit was found to have brown patches upon them, which are more or less soft to the touch, and which, soon after unpacking, develop saprophytic moulds. The damage is sometimes quite serious, a fair proportion of many cases turning out in this unsatisfactory way, but these proportions vary from case to case and from shipment to shipment."

Associated with the decomposing fruit were two fungi, one a species of *Penicillium*, the other a *Rhizopus*. The various species of both these genera usually live as saprophytes and are frequently found on decaying vegetable products; some species of both, however, are known to be active agents in *producing* decay when they obtain access to fleshy vegetable tissues through cracks or other perforations of the protective outer layers.

It was at first thought that the *Penicillium* was responsible for the greater part of the injury, but an examination of some of the tomatoes, which had been reduced to a very soft, pulp-like mass, revealed ramifying through this pulp a coarse-looking, copiously branched, nonseptate mycelium. The presence of such mycelium which is typical of that class of fungi including *Rhizopus* and its allies, but excluding *Penicillium.*, *viz.*, the *Phycomycetes*, suggested that *Rhizopus* rather than *Penicillium* was the cause of the greater part of the rot, especially as further examination showed that the mycelium associated with the latter was practically confined to those localized areas where the fungus appeared at the

surface, while the non-septate mycelium was found, in some cases, to extend beneath the skin to a considerable distance from the spots where the *Rhizopus* fructifications were to be found. It was therefore thought advisable to carry out inoculation experiments with tomatoes, using the spores of this fungus, which proved to be *Rhizopus nigricans* Ehrenbg., in order to obtain some knowledge relative to the rate of progress of the disease and the extent of the injury caused by it.

This work has been carried out by my assistant, Mr. H. Wormald, and the results obtained are given below (see p. 381).

Rhizopus nigricans is one of the so-called "Black Moulds," and is closely related to the Mucors. When first described in 1818 it was named *Mucor stolonifer* Ehrenbg., but it differs from the typical *Mucor*, as for example, *Mucor racemosus*, which produces an apple rot, in certain well-defined characters, and the generic name *Rhizopus* has since been adopted. The features distinguishing this genus from *Mucor* are as follows:

(1) The aerial mycelium takes the form of stolon-like hyphæ from which the sporangiophores arise in groups of two to six, and at the base of each group short rhizoid-like much branched hyphæ are developed, forming an attaching organ.

(2) In *Rhizopus* but not in *Mucor*, there is an enlargement of the sporangiophore immediately below the columella; this enlargement is known as the apophysis.

(3) The spore wall of *Rhizopus* is folded or ridged, seen best when the spores are dry, while in *Mucor* it is either smooth or provided with minute spines.

Previous work on *Rhizopus nigricans* shows that this fungus, which is widely distributed as a *saprophyte*, must be considered as a *facultative parasite*.

In 1890 Halstead found it causing a soft rot of sweet potatoes in the United States. Comes, in his "Crittogamia agraria," published in 1891, in referring to this fungus under the name *Mucor stolonifer*, states that though it usually lives on dead vegetable tissue, it may attack fleshy fruit and produce rapid decomposition. Behrens (1895) observed it at Karlsruhe causing destruction in tomato beds, especially in those cases where the fruit was hanging very low and had

become soiled in consequence. Brief reference is made to certain experiments in which he produced the rot in two red tomatoes and in a green one, by inserting mycelium of *Mucor stolinifer* in wounds, and he similarly artificially infected among other fruits, raspberries and currants. Nordhausen (1878) stated that the same fungus, after receiving saprophytic nourishment, such as would be provided by the ruptured cells when a wound or bruise is made on a fleshy fruit, is then able to attack *living* cells and destroy the tissues. Jaczewski (1908) describes *Rhizopus nigricans* as causing a rot of apples, but only when the skin was injured by insect punctures, by cracks, or by bruises. In the following year Orton showed that in California this fungus produces a " soft rot " in potatoes grown in the peat lands of California. The fungus, on gaining an entrance to the tuber, discolours and softens the flesh, and ultimately a clear brown liquid exudes when the potato is pressed. The disease spreads rapidly in warm weather, and entire shipments may decay on their way to market. It is stated that to prevent infection the skin should not be broken in handling.

Last year (1912) Schnegg reported that it had appeared as a parasite on the roots of " Grünmalz."

Other species of *Rhizopus* also behave as parasites, as was shown by Massee in the case of a Japan Lily Disease caused by *Rhizopus necans*, and by Raciborski, who described a species *R. artocarpi*, as attacking and completely destroying the living inflorescences of *Artocarpus incisa* in Java.

THE *CYTOSPORA* DISEASE OF THE CHERRY.

(Plates VII. to XXII.)

By H. Wormald, A.R.C.S., B.Sc.

During the year 1910 many fruit-growers in Kent, farming in the districts of Bapchild, Lynsted, Rodmersham, Newington, Teynham, Ospringe, Petham and Yalding, experienced considerable loss owing to the death of a large number of young cherry trees. Just as these had attained an age when a profitable yield was anticipated for the season, a high percentage showed signs of wilting (usually early in the year), and in the course of a few months were quite dead.

Some estimation of the havoc caused by the disease may be obtained from the fact that the number of trees lost by five growers in that year amounted to no less than 730. One of them alone lost 220 in eighteen acres, or about 35 per cent., and another reported 100 in eight acres. As many as 300 were destroyed on one farm, and although in this particular instance the total acreage under cherries was much greater than in the two cases just quoted, so that the average number lost per acre was lower, yet in one part of a plantation on that farm, planted with young cherry trees of the "Noble" variety, which has proved to be very susceptible to the disease, the death-roll reached 75 per cent. Other growers report the loss of many cherry trees, but were unable to supply accurate figures. The age of such trees which were killed outright in one season was almost invariably from six to ten years. When older trees were attacked the injury was more localized, but even then whole branch-systems or even one or more of the large primary limbs succumbed.

In 1911 the disease was less severe than in the previous season, but in one orchard the number only dropped from seventy in 1910 to fifty in 1911. Two possible explanations

may be advanced to account for the diminished intensity of the attack that year: (1) the most susceptible trees had been destroyed in 1910; (2) the summer of 1911 was very dry and unfavourable for the growth and spread of many fungoid pests, one of which, there are reasons for believing, is responsible for this epidemic. In some plantations, as the trees die, the gaps are filled, not by cherry trees, but by apple, pear, or plum trees, for until the disease is under control, cherry growing in those plantations is becoming unprofitable.

Plates VII. to X. are from photographs taken during 1912 and show cherry trees with the disease at various stages of attack; those shown on Plates VII. and IX. have a few dead branches, that on Plate X. is dead along one side, and that on Plate VIII. is almost killed outright.

The photographs show that diseased trees are to be found both in orchards grazed by sheep and in plantations.

Susceptibility of Certain Varieties.

From information received from various growers the Napoleon and Noble varieties have suffered most, but the following have also been seriously attacked: Florence, Waterloo, Old Kentish Bigarreau, Bedford Black, Rodmersham Seedling, Amber and Black Eagle.

Several growers have found that Rivers' Early is immune, or almost so. One who grew eight varieties supplied the following information regarding the trees grown on his farm:

Black Eagle was attacked worst of all.

Old Kentish Bigarreau, eighty-one lost out of 140.

Napoleon and Waterloo, disease less severe than in the above two varieties.

Early Rivers and Early Black, very few attacked.

Eltons and Frogmore, free from disease.

Symptoms of the Disease.

As already mentioned, when young trees (six to ten years old) are attacked they are, as a general rule, killed outright in one season. Such trees have most or all of the following characteristics:

(*a*) The leaves show a general yellowing and wilting, commencing at the tips of the shoots. The leaves may begin

to wither in May, and the whole of the upper part of the tree will be dead by October.

(*b*) Shoots arise from the base of the stem. These shoots are sometimes numerous and very vigorous and doubtless originate in dormant buds which have been stimulated to growth by the accumulation of sap in the lower part of the tree, for as the upper portion becomes affected the vessels are blocked up with wound gum and later by fungal hyphæ.

(*c*) Cracks appear in the bark usually at the crown or at the base of the trunk, or at both places, and from the cracks oozes a viscid gum, which remains soft and viscous during wet weather (for it is easily soluble in water), but becomes quite hard and resin-like in appearance as it dries.

(*d*) Dark discoloured areas are to be seen on the green bark of the younger branches; these discolorations are not so evident on the older parts of the tree, but if a cut be made into the bark it will be seen to be brown and dead. If a cut be made across a diseased branch or stem, the wood, too, is seen to be discoloured; when the disease is well established the whole of the cut surface is very much darker than normal wood, while in the earlier stages this abnormality in colour is usually seen as a sector of a circle extending from the bark to the pith. The colour is due to the formation of "wound-gum" in the cells of the medullary rays and in the vessels. This "wound-gum" is *not* soluble in water.

(*e*) Sooner or later pustules of a species of *Cytospora* appear bursting through the bark; from these pustules, under suitable conditions, the spores are extruded in mucilaginous, tendril-like threads, dark red in colour.

Older trees show the same symptoms on the affected branches, often with the gumming at the crown and base of the stem. The outgrowth of shoots from the base of the stem is not so typical for these older trees since the whole of the upper part of the tree is not killed and the upward flow of sap is not altogether prevented.

Previous Work on the Cherry Disease.

This disease, which is now so prevalent in Kent, appears to be identical with one known on the Continent as the "Rheinisches Kirschensterben." In 1903 the subject was

discussed by Aderhold (1)* who came to the conclusion from a series of inoculation experiments that the fungus *Valsa leucostoma* (Pers.), with its conidial form *Cytospora leucostoma*, was responsible for the death of the trees. He thus confirmed the work of Frank, who had already stated that a *Cytospora* of parasitic nature was the cause of the disease, though he referred it to the species *C. rubescens*. On the other hand, Goethe, Sorauer, Zapfe and Labouté considered that spring frosts are the active agent, and that the fungus follows the injury, and is not the primary cause of the disease. More recently Lüstner (2) in 1907 claimed to have found that brilliant sunshine causes transpiration to be so excessive that the roots are unable to provide an adequate supply of water, and the leaves show signs of withering in consequence. Ewert (3) in 1908 suggested that the "Rheinisches Kirschensterben" was the result of the roots reaching an unsuitable subsoil; one that is stiff and impermeable tends to produce a water-logged condition detrimental to the roots which are thus unable to perform their absorptive functions and the supply of water to the leaves is diminished. Working in America, Rolfs (4) finds *Valsa leucostoma*, the conidial form of which he refers to *Cytospora cincta*, causing "winter-killing" of peach trees, and with the fungus he was able to infect cherry trees as shown by the following quotation from his paper:—"Cultures of both the *Cytospora* and *Valsa* forms were obtained from the peach (*Prunus persica* L.); the plum (*Prunus triflora* Roxb.); the apricot (*Prunus Armeniaca* Willd.); the red cherry (*Prunus cerasus* L.); the wild cherry (*Prunus serotina* Ehrk.). Cross inoculations were made on each of these varieties. These inoculations show that both forms from each of the above-named varieties grow interchangeably on all five varieties of trees, and in each instance the fruiting bodies resulting from the cross inoculation have the same general structure as those that occur on the trees naturally."

The Fungus.

The fungal mycelium flourishes in the cortex, immediately beneath the periderm, but it also invades the bast and eventually the wood. In the latter the hyphæ usually take a

* The numbers refer to the Bibliography on p. 380.

horizontal course in the medullary rays, while in the vessels they grow vertically. Similar behaviour was noticed in *Nectria ditissima* by Goethe (5), and probably merely indicates that the fungus grows along the path of least resistance, the number of cell-walls encountered being reduced to a minimum when, as here, growth is in the direction of the longest axis of the cell or vessel. The growth of the mycelium beneath the periderm is such that lenticular sclerotia-like stromata of densely interwoven hyphæ are produced; these are the immature fructifications and as they increase in size the bark assumes a blistered appearance; if, at this stage the outer portion of the bark be removed, each "blister" is found to contain a stroma (Plate XI.). As growth proceeds, chambers appear in the stromatic mass of hyphæ; these chambers (pycnidia) become lined with a dense layer of conidiophores, which form a distinct hymenial layer. Meanwhile the pressure from beneath causes a horizontal slit to appear in the bark and this slit increases in width until the spore-producing body is to be seen as a pustule, the exposed surface of which at maturity is flattened, circular or elliptical in outline, white in colour and pierced by one or several pores, which have the appearance of black dots when the spores are not oozing out. The chambers in the stroma communicate with the exterior through the pores, and under suitable conditions of moisture and temperature the spores exude through the apertures embedded in mucilage, the mass of spores and mucilage being of such a consistency, unless the atmosphere is too moist, that the protrusion causes it to assume the form of a curled thread or tendril. Each "tendril" contains thousands of minute, continuous, allantoid (sausage-shaped) conidia (Plate XXII.) The basal portion of the stroma consists of a dense felt of fungal hyphæ, in which are embedded cortical cells of the host, a condition which is typical of the perithecia-containing stromata of the *Valsaceæ* (Plate XVI.)

The conidia are abstricted from the apices of the sparingly branched conidiophores forming the hymenium, which in places projects into the cavity so that the area of the hymenial surface is considerably increased. As already stated, the tendrils are red, but the conidia when seen singly are hyaline. They are not ejected from the cavities as soon as formed,

but they accumulate, forming a red mass which may completely fill the cavity, until conditions are suitable for their protrusion ; these conditions include moderate moisture and temperature. It has been noticed on several occasions during the colder months of the year that material collected and placed in a vasculum in the laboratory had produced tendrils by the following day, although no tendrils were to be seen while it remained in the open. Throughout the winter no difficulty was experienced in obtaining spores when required ; a portion of diseased cherry bark with pustules, when put with damp blotting paper into a glass capsule and kept at a temperature of 26°C. in an incubator invariably produced spores in quantity within twenty-four hours, though usually under such conditions owing to the relatively high degree of moisture in such a confined space the spores did not form tendrils but a slimy, red liquid, which flowed over the bark.

When a portion of a tendril is placed in a drop of water it breaks up into its constituent conidia, which stream away into the water ; this streaming, though very rapid, is not continuous, but pulsating, for a large number of conidia may be seen to shoot suddenly away from the main mass, after which there is a pause, followed by the liberation of another cloud of conidia. In water these exhibit Brownian movement, for their dimensions are so small that they are almost bacterial. They measure 4-6 μ by 1 μ, and the conidiophores bearing them are about 15 μ long.

On one occasion the fungus was found associated, on a young cherry tree, with a beetle which pierces the bark. The beetle was identified by Professor Theobald as the fruit-bark beetle, *Scolytus rugulosus*, a common pest of the plum but not usually found on the cherry in this country, and it is interesting to note that this insect is the " Borkenkäfer " mentioned, under the name *Eccoptogaster rugulosus*, by Frank as being associated with the " Rheinisches Kirschensterben."

Every affected cherry orchard visited up to the time of writing has yielded *Cytospora* fructifications on either dying or dead trees, and the frequency of the appearance of the fungus suggests the possibility of a parasitic habit ; this is emphasized by the fact that the pustules (fructifications) are

to be found in close proximity to living tissue, and that the upper part of a tree, *i.e.*, from the middle of the trunk upward, may be almost covered with the pustules while the lower part is apparently quite sound, the bark and wood having the normal colour of the living tissues. That the roots and lower portion of the stem retain their vitality longer than the rest of the tree, is shown in many cases by the vigorous growth of the shoots which have been induced to grow from the base of the stem and by the green and healthy appearance of such shoots after the death of the upper portion of the tree. In one case a branch of a young tree began to show signs of loss of vigour; an examination showed that near the base of the branch were young pustules of *Cytospora leucostoma*, and the bark in their vicinity on being cut into proved to be brown and dead.

Though these observations suggest parasitism they by no means prove it, and the present investigation was undertaken with the object of ascertaining the relationship between the fungus and the disease. In order to determine whether or not *Cytospora leucostoma* is to be regarded as a parasite in this country, inoculation experiments with mycelium and conidia from pure cultures are essential. The fungus grows readily saprophytically; pure mycelium is easily obtained on any of the usual culture media, and pycnidia with tendrils have been obtained on a few of them. During the year 1912 inoculation experiments, using mycelium and conidia from pure cultures, were carried out, but up to the present they have yielded negative results, and other inoculations will be made this year.

The mode of growth of the fungus on the media employed is set out below.

Cytospora IN PURE CULTURES.

On December 18th, 1911, a small portion of a *Cytospora* "tendril" obtained from a pustule on the bark of a diseased cherry tree was placed in sterilized water, and when the conidia were diffused throughout the liquid, isolation poured plate cultures were prepared in sugar-beet agar. By the middle of January, 1912, the resulting mycelium on some of the plates had produced stromata, and on February 1st one

of these was seen to be bearing at its apex a dark-red globule, which proved to be an incipient "tendril." On the following day isolation cultures on prune-juice agar were prepared from the conidia of this globule, and on February 17th more cultures were started from a similar mass of conidia. From the mycelium obtained in this way, sub-cultures on various media were made, with the following results :—

I.—On Sterilized Vegetable Products.

(1) Potato—semi-cylinders (cylindrical portions cut diagonally) in test tubes.

Growth slow, mycelium forming a thin dense layer, yellowish brown in colour, sporiferous stromata formed, no spores protruded, but on crushing *Cytospora* conidia were to be seen.

(2) Carrot—semi-cylinders in test tubes.

Growth rapid, mycelium dark brown, forming a thicker layer than on potato but with a looser texture ; sporiferous stromata formed with protrusion of spores in the form of red droplets but no definite tendrillous threads.

(3) Sugar-beet—semi-cylinder in test tube and slices in Petri dishes.

Growth moderate, rate of growth intermediate between (1) and (2) ; mycelium white ; sporiferous stromata produced.

(4) Apple—slices in Petri dishes.

Growth very rapid, mycelium very delicate and practically invisible on the apple itself, but can be seen when it grows out into the liquid that has come from the fruit during sterilization ; no traces of stromata.

(5) Pear—slices in Petri dishes.

Growth moderate, mycelium dirty grey in colour ; stromata produced but hitherto no protrusion of conidia has been observed although this was the medium on which Aderhold obtained conidia for his inoculation experiments.

(6) Portions of branches from cherry tree—the branches were cut into suitable lengths, then cut longitudinally so that both wood and bark were exposed ; some pieces were placed on damp blotting paper in Petri dishes, others in test tubes with damp cotton-wool, before sterilization.

Growth moderate, mycelium grey, growing over the exposed surfaces of the bark and wood ; stromata superficial (*i.e.*, not produced inside the bark as in the natural habitat in the open) and, as a rule, most numerous along the exposed edge of the bark. Those pieces in Petri dishes have been the most proliferous in conidia production, and well-developed curled " tendrils " have been obtained (Plate XXI.).

II.—On Nutrient Agar.

(1) Prune juice agar : growth fairly rapid, but not equal in all directions, so that the margin is lobed ; the culture is very dark but with a pale peripheral zone ; no stromata even in cultures three months old (Plate XVII.).

(2) Sugar-beet agar : growth slow, the mycelium forms a grey zonate disc, almost circular in outline, not lobed ; the largest hyphæ have, in general, a directly radial course, giving the appearance of radiating striæ ; stromata are produced with incipient " tendrils " (Plate XVIII.).

(3) Maize meal agar : growth rapid ; mycelium very fine and white, having a silky appearance ; stromata very small, the largest being about 0.5 mm. in diameter.

(4) Nutrient agar prepared from an extract of cherry wood and bark ; growth very rapid ; mycelium white ; stromata with a loose peripheral weft of hyphæ.

The poured plate cultures from conidia in sugar-beet agar and prune agar have the same characteristics as the sub-cultures on these media, except that in the former when the conidia are numerous the growth of the hyphal masses is very limited and the product of each conidium forms, in a very short time, a kind of stroma which on crushing yields conidia.

In order to compare the rate of growth on the four media mycelium was transferred on May 22nd, 1912, from one culture to a plate of each of the four. On June 11th the cultures on these plates had the following dimensions, the figures giving the diameter.

Sugar-beet agar, 1.8 cm.
Prune agar, from 2.8 to 3.5 cm.
Maize meal agar, from 5 to 7 cm.
Cherry wood extract agar, from 5 to 7 cm.

It will be seen that of the four the most promising stromata from the point of view of spore production were formed on the sugar-beet agar, but better results were obtained by covering over a vigorous culture on prune agar nine days old with a layer of sugar-beet agar. Further growth laterally was inhibited, but the mycelium grew upwards through the agar covering and formed numerous stromata, from some of which protruded eventually short "tendrils"; these stromata were limited to a peripheral zone from half an inch to one inch in width, the central portion (about one inch in diameter) remaining sterile (Plate XIX.). A covering of sterilized blotting paper, or of 3 per cent. agar without nutrient, checked growth, and no stromata were produced.

One plate culture on sugar-beet agar showed a "halo" or opalescence in a zone extending from the margin of the culture outwards for from 4 to 5 mm. The opalescence was found to be due to numerous crystalline particles, the chemical nature of which was not determined; similar particles, though smaller in size, were to be found scattered throughout the agar. It would seem that in this medium there is some substance that has a tendency to crystallize out and that this tendency is intensified in the vicinity of the fungus. The presence of the "halo" is interesting as it indicates that the fungus is able to exert an influence on material to which the hyphæ have not extended, even though that influence be merely one in the direction of causing dessication of the substratum. If the *Cytospora* is able to cause a change at some distance from itself in an inert substance like nutrient agar, there is the possibility that in a living tree where foodstuffs are being transferred from one location to another, changes, chemical or physical, may be induced at even greater distances.

On March 2nd, 1912, a portion of bark with young stromata taken from a branch of a diseased cherry tree, was washed with absolute alcohol and two of the stromata, which had not yet burst their way through the outer layers of the bark to the exterior, were dissected out in sterilized water, then washed in sterilized water and one placed on a prune agar slant, the other on a sugar-beet agar slant in test tubes. The resulting cultures, allowing for the confined spaces, were respectively

similar to those described above for the sub-cultures on those media in Petri dishes.

Germination of the Conidia.

The behaviour of the conidia on germination was studied in hanging drop cultures. The conidia when removed from the "tendril" are seen to have the form of minute curved rods with rounded ends (technically described as allantoid or botuliform), the dimensions being about 5μ. by 1μ. Before

Fig. 3.
Conidia of *Cytospora leucostoma*, in various stages of germination, in a hanging-drop culture (sugar-beet extract) three days old; some have remained unchanged. × 350.

germ tubes actually protrude from them they increase enormously in size; the width increases at a greater rate than the length, the optical section of the germinating conidium gradually becoming a narrow ellipse and eventually almost circular. The length immediately before the germ tube appears is from one-and-a-half to three times that of the original, while the width increases usually seven to ten times (Fig. 3). One conidium which was growing in an extract

of cherry twigs and which was measured a short time after germination had commenced was found to be 15μ by 11μ, omitting the germ tube; others were found to be 13μ by 10μ. In prune extract and in extract of sugar-beet they have not been seen greater than 8μ by 6.5μ before germination. The first indication of further development is the change in shape, the almost spherical cell becoming ovoid or pyriform, and the narrower end grows forth as the first hypha; sometimes two or even three germ tubes arise, but, of these, one usually developes at a distinctly greater rate than the other.

In a nutrient liquid at ordinary temperatures the conidia may attain a maximum size and commence to germinate within forty-eight hours. The time which elapses before germination is, however, very variable, even in the same drop of liquid and often after a few days all transitions from conidia apparently unchanged to others with very long germ tubes may be seen in the field of the microscope at the same time (Fig. 3).

No germ tubes have yet been observed in hanging drops of distilled water, and although an increase in the size of the conidia up to 8μ by 6μ has been seen in one culture, in two others no apparent change occurred during the lapse of thirteen days. At the end of that time to one of the latter a drop of prune extract was added, but this had no influence on the conidia. No change whatever has been noticed in sterilized tap water. Two hanging drops of this medium were prepared, and after thirteen days a drop of prune extract was added to one of them, with the result that within two days after adding the nutrient some of the conidia become swollen, and several had produced germ tubes 10μ long (on the next day the length had increased to 300μ), while those in the drop consisting of tap-water only still remained unchanged.

The results seem to indicate that for germination the conidia require a medium containing organic food stuffs, and that in the earlier stages of its existence it lives as a saprophyte, also that if the *Cytospora* is at all parasitic it must be a wound parasite, for it would be able to gain access to organic materials only by the rupture of the plant cells.

A curious budding process occurred in one prune extract culture (Fig. 4). The germ tubes remained relatively quite

short, often no longer than 15μ or 20μ, and from them terminally (sometimes forming an apical cluster of four or five), or laterally, elongated cells, often slightly curved, sometimes clavate, were abstricted. This budding may be looked upon as precocious conidia production. Lapine (6)* found conidia to be produced on the mycelium from conidia of *Nectria ditissima* in hanging drops. On the other hand it is well known that many fungi are stimulated to vegetative reproduction by the abstriction of cells when growing in nutrient media.

CONTROL.

Although definite proof of the parasitism of *Cytospora leucostoma* in this country is lacking, the experiments of Aderhold in Germany and Rolfs in America warn us that we must look upon the fungus with suspicion, but until the real cause of the disease has been ascertained, advice with regard to its control can only be advanced tentatively. When young cherry trees show that they are being attacked the grower is advised to remove and burn them promptly. Diseased branches of the older trees should be cut back until all discoloured bark and wood has been cut away and the exposed surface should be covered with Stockholm tar.

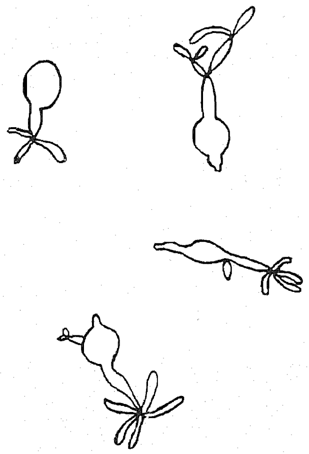

Fig. 4.
Germinating conidia of *Cytospora leucostoma*, showing "budding," × 700.

Spraying is of little or no use, even if futher research should prove that the fungus is a true parasite of the cherries in Kent, for it lives entirely within the tissues of the host, and appears at the surface only to disseminate its conidia. Removal and burning of affected parts on the first symptoms of disease would prevent the production of the "tendrils" with their millions of spores.

* The numbers refer to the Bibliography on page 380.

The photographs shown on Plates XVII. to XXII. were kindly prepared by Mr. W. H. Hammond, of Canterbury.

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EXPERIMENTS WITH *RHIZOPUS NIGRICANS* ON TOMATOES.

By H. Wormald, A.R.C.S., B.Sc.

(Plate XXIII.)

No difficulty was experienced in obtaining vigorous growth of the fungus in pure cultures on nutrient agar, prepared from prunes, sugar-beet, maize-meal or potatoes, and on sterilized potato. On the latter is produced a dense mass of mycelium and numerous sporangia, while on the sugar-beet agar vegetative growth was not as vigorous, though sporangia were formed plentifully, and growth was still less vigorous on maize-meal agar. One culture was grown on prune agar in a Petri dish and placed in an incubator at 26° C.; in twenty-four hours a disc of mycelium 1.9 cm. in diameter had developed, and in seventy-two hours from the time the inoculation was made the disc measured from 6 to 7 cm. in diameter.

Spores germinated readily in hanging drops of prune extract. On January 7th, at 3 p.m., spores were placed in this nutrient liquid and examined on the following day at 11 a.m., when the spores were seen in various stages of germination, the longest germ-tube that came under observation was 1.2 mm. in length.

In the following experiments the spores of the fungus were used and two methods of transferring these spores to the spots selected for inoculation were employed, *viz.*:

(1) When the spores were taken from the cultures growing on tomatoes sporangia were removed by flamed forceps and placed in a little sterilized water in a watch glass; spores were liberated immediately by the bursting of the sporangia and drops of water containing spores were transferred to the tomatoes to be treated by means of a platinum wire loop.

(2) When test tube cultures of the fungus growing on

sterile media were used a drop of sterilized water in the platinum loop was brought in contact with a ripe sporangium; spores were discharged at once into the water and the inoculations carried out as usual.

Most of the tomatoes used in the experiments were obtained from the greenhouse connected with the College fruit plantation, since it was found that these gave the most satisfactory result. Those bought from fruiterers were, as a rule, unsuitable for inoculation, for the experiments were vitiated by the growth of other fungi, while those obtained direct from the glasshouse produced, after inoculation, cultures which were practically pure; in some cases, so far as could be ascertained, they were absolutely so, while in the others a few colonies of other forms appeared after the experiments had proceeded for some weeks.

Experiment I.

May 30th, 1912.—In this preliminary experiment a sound and quite ripe tomato, selected from those sent in for examination, was washed with distilled water, and a wound, piercing the skin, was made by means of a flamed scalpel. Spores of *Rhizopus* were placed on the wound.

June 3rd.—Sporangia appeared on the wound; round the point of inoculation was an area 5 cm. in diameter, where the skin was depressed, the flesh beneath being quite soft and pulpy, and here the colour of the skin was not so brilliant a red as over the rest of the surface. The affected area was therefore somewhat sharply defined, and the progress of the fungus could be easily followed, at any rate in the early stages.

June 4th.—The affected area was 7.5 cm. in diameter. At one spot at the edge of this area a cut was made through the skin and a small portion of the flesh was removed for microscopical examination. A coarse branched mycelium similar to that found in the rotting tomatoes was seen. In water this mycelium was easily teased out free from the partially destroyed cells of the pulp, and after it had been washed in sterilized water it was placed on nutrient agar, on which developed a *pure* culture of *Rhizopus nigricans*.

June 5th.—Sporangia had appeared at the spot where the

skin had been cut for the removal of the mycelium about twenty-four hours previously.

June 14th.—The tomato by this time had become quite soft and numerous aerial hyphæ bearing sporangia were growing over the surface.

The experiment showed that the fungus has the capacity of growing through the flesh beneath the skin of the tomato, and may appear at the surface, with the production of sporangia, through any perforation of the skin.

Experiment II.

June 4th.—Two tomatoes which were barely ripe were taken from plants growing in the glasshouse connected with the College fruit plantation. Five small punctures, over an area of about one-sixth inch square, were made through the skin of each with a sterilized needle, and on these wounds were placed *Rhizopus* spores. The tomatoes were then kept on damp blotting paper in a large Petri dish.

June 7th.—Infection had not taken place, possibly because a protective layer had been formed before the fungus gained entrance, as a thin pellicle was to be seen covering each puncture. On the opposite side of each fruit two small cuts crossing at right angles and about one-eighth inch long were made, causing the juice to just ooze out of the wound. On the wounds was placed a drop of sterilized water containing spores from a black sporangium growing on the tomato inoculated May 30th (see Experiment I.).

June 9th.—The wounds had increased in size by the cracking of the skin. Round each centre of inoculation was a depression 1.5 cm. in diameter.

June 10th.—The diameter of the area of sunken skin was on the average 4.5 cm., the rest of the flesh was quite firm.

June 11th.—Diameter of sunken area had increased to 8 cm. A white felted mass of mycelium, bearing immature sporangia, was growing over the cracks.

June 12th.—More than half of each tomato was soft by this time.

June 13th.—The skin at the edge of the sunken portion of one tomato was lifted in order to examine the pulp for

mycelium, which proved to be present and similar to that examined on June 4th.

June 14th.—Immature sporangia were now to be seen where the wound was made on the previous day.

(Compare Experiment I. June 4th and 5th.)

The tomatoes eventually became a pulpy mass, covered with a dense growth of *Rhizopus*.

EXPERIMENT III.

On June 14th three tomatos were obtained direct from the greenhouse and treated respectively as follows :—

No. 1.

June 14th.—This tomato was punctured on one side; on the opposite side it was slightly bruised (the bruise being about 2 cm. in diameter, and not breaking the skin) before similar punctures were made; inoculations were made on the wounds as usual. In the former case, where the skin was pricked but not bruised no infection occurred; in the latter, the usual signs of the *Rhizopus* rot were soon in evidence, and the following observations were made.

June 19th.—Three cracks appeared; the edge of the affected area was from 1.5 to 2.7 cm. from the centre of inoculation; traces of aerial mycelium were to be seen over the wounds.

June 20th, 8.45 p.m.—The affected area now extended from 2.5 to 5.0 cm. from the centre of inoculation. In order to ascertain the rate of progress of the rot, the periphery of the area under observation was marked in ink, successive markings being made at intervals of twelve hours.

June 21st, 8.45 a.m.—The tomato was affected over about hal the surface; the extension of the rot during the prev ous twelve hours as shown by the distance of the periphery from the ink mark was from 4 to 8 mm.

June 21st, 8.45 p.m.—Extension of rot during previous twelve hours, 4 to 4.5 mm.

June 22nd, 8.45 a.m.—Extension of rot during previous twelve hours, 2 to 3 mm.

8.45 p.m.—Extension of rot during previous twelve hours, 2 to 4 mm.

June 23rd, 8.45 a.m.—Extension of rot during previous twelve hours, 2 to 3.5 mm.

8.45 p.m.—Extension of rot during previous twelve hours, 1 to 3 mm.

June 24th., 8.45 a.m.—Extension of rot during previous twelve hours, 0.5 to 3 mm.

June 25th.—The tomato was now quite soft, this result being partly due to the reinoculation, at the spot where the first inoculation had failed, by the mycelial "stolons" which, originating at the point of infection, had grown over the surface of the fruit, and had reached the other side. These aerial hyphæ had increased in length even more rapidly than the mycelium under the skin and four of the punctures were by this time each covered by a tuft of hyphæ from which numerous sporangiophores were growing. It is evident that the aerial hyphæ are capable of invading the fruit through wounds.

No. 2.

June 14th.—The stalk of this tomato was removed, and spores were placed in the hollow so formed.

June 16th.—A crack appeared at the stalk end.

June 23rd.—The inoculation had failed, so the tomato was placed in contact with tomato No. 1 of this experiment, which by this time was badly infected (see above, No. 1, June 21st to 25th).

June 26th.—Infection had resulted through the crack, and the affected area extends 1.8 to 2.8 cm. from the middle of the crack.

As the infection resulted immediately after the wound was placed in contact with the fungus, the inference is that an attack had been made through the wound by the *Rhizopus* growing on the other tomato.

No. 3.

June 14th.—This tomato was uninjured, and the stalk was left intact. A drop of water with *Rhizopus* spores was placed round the base of the stalk *i.e.*, on the calyx ; this was thought to be the most vulnerable spot of the uninjured fruit, for as the stalk and calyx died they would provide saprophytic nourishment.

June 26th.—The tomato was still sound, so it was placed in contact with No. 1.

July 23rd.—As no infection had taken place it was washed and replaced in contact with No. 1, the stalk on this occasion being removed.

Infection must have occurred almost immediately, for on July 7th rot had extended from 1 to 3 cm. from the stalk end, and on the following day sporangia appeared at the place where the stalk had been.

Experiment IV.

August 27th.—Three tomatoes obtained from a grocer's stores were placed in a large Petri dish and treated as follows :

No. 1.—Skin broken and spores placed on wound.

No. 2.—Stalk removed and the wound thus made still further enlarged before inoculation.

No. 3.—Stalk removed and spores placed on the stalk-end without further injury.

September 2nd.—No. 1 showed the typical symptoms of the rot over half its surface. Nos. 2 and 3 were apparently unaffected.

September 11th.—No. 1 covered with mycelium bearing numerous sporangiophores. No. 2 now showed the rot ; the probability is that it became inoculated by the mycelium from No. 1, with which mycelium it was in contact. No. 3 had many mycelial " stolons " (having their origin in tomato No. 1) growing over its surface but no rot had appeared.

A few days later, however, No. 3 also succumbed, and on September 19th, about half the surface showed the sunken appearance indicating the decay of the flesh beneath ; an examination of this soft flesh again revealed the presence of the coarse mycelium as seen in the soft tissues of the other tomatoes attacked by this fungus.

Experiment V.

November 5th.—Mr. W. Voss* sent a number of tomatoes for inoculation experiments ; five were treated as follows :—

No. 1, which was already cracked, was placed without inoculation in a Petri dish with Nos. 2 and 3.

(It soon became impure and had to be destroyed.)

* See above, p. 364.

Nos. 2 and 3, unripe fruit and quite green, were inoculated from a pure test-tube culture after wounding (slight bruise and a small cut with a scalpel).

On November 15th evidence of the rot was seen over three-quarters of the surface of each; both had copious aerial mycelium and numerous black sporangia (see photograph at Plate XXIII).

No. 4 was cut with a sterilized scalpel and placed in the dish of *Rhizopus* resulting from Experiment IV.

No. 5 was bruised, but without breaking the skin, and placed in the same dish, with the bruised side in direct contact with the fungus.

On November 28th neither 4 nor 5 showed signs of the *Rhizopus* rot and as other fungi began to appear the experiment was not continued.

Experiment VI.

December 20th. Three tomatoes were obtained from the College greenhouse; two were unripe, the third being just ripe. The stalks being removed from all three, the green tomatoes were inoculated after being punctured, and were placed in a Petri dish with the ripe one (which was not injured apart from the removal of the stalk) between them. The inoculations again were made from test-tube cultures.

The dish was not examined until January 13th, when the tomatoes were found to be entirely hidden by a dense growth of *Rhizopus* and all three seemed completely destroyed. On January 23rd, the stalk was removed from another ripe tomato (again obtained direct from the plant), which was then placed upon the mass of mycelium and sporangia in the dish. On the 28th it was re-arranged so that the stalk end was directly in contact with the fungus. It was still quite sound, however, when examined on February 20th, thus proving that it is possible for fruit with uninjured skin, even though the stalk be removed, to remain in contact with *Rhizopus* for four weeks without being attacked by the fungus.

The conclusions to be drawn from the experiments are :—

(1) *Rhizopus nigricans* is a wound parasite which is capable of producing a rapid decomposition of the fleshy tissue of tomatoes, even in the case of green, immature fruit.

(2) Neither the germ tubes from the spores nor the aerial hyphæ are able to penetrate the skin of a sound tomato, but they may gain an entrance by way of cracks (the usual method), or by punctures.

(3) The aerial hyphæ are more virulent than the germ tubes produced from the spores.

(4) The rot is favoured by the presence of bruises.

(5) The fungus may or may not gain an entrance when the stalk is removed from the fruit; sometimes the removal of the stalk, especially if the tomato is not quite ripe, results in cracking when contact with the fungus is almost certain to result in infection.

Rhizopus nigricans, as the experiments described above show, is unable to penetrate the uninjured skin of tomatoes (thus confirming the work of previous workers), but the mycelium grows rapidly immediately it reaches the fleshy tissue by means of a wound. The mycelium produced is of two types, which are quite different in appearance: (i.) that embedded in the flesh of the tomatoes; (ii.) that which is superficial. The two are usually connected by a felt-like mass of hyphæ covering the wound at which the fungus gained an entrance. As already mentioned, the mycelium found within the fruit is much branched, is non-septate and coarse in appearance; examined microscopically, the older portions are found to be about 25μ ($\frac{1}{1000}$ in.) in diameter. When it reaches another wound it immediately produces the second type. The aerial mycelium which grows over the surface of the tomato and often, too, over neighbouring objects, originates at a wound and consists of long hyphæ which are often called "stolons," for in their mode of growth they behave somewhat like the stolons or "runners" of the strawberry plant (Fig. 5). The apex of such a hypha on touching the substratum develops a number of radiating rhizoids (root-like threads) which act as an organ of attachment. As growth

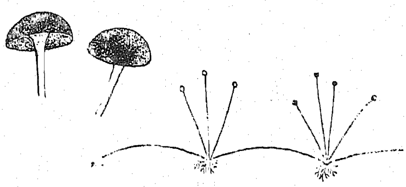


Fig. 5

Rhizopus nigricans × 3. On the left is shown the form assumed by the *dry* columella, after the spores have been shed.

proceeds the apex describes a curve above the surface of the substratum, descending again to form another cluster of adhesive rhizoids at some distance from the former. At these points of contact, which may be called the "nodes," the sporangiophores develop in a small group of two to four, rarely five or six. Each sporangiophore reaches a height of about 3mm. ($\frac{1}{4}$-inch) and produces at the upper free end a single sporangium, which at first is white but later becomes dark brown or black as the spores reach maturity. The sporangiophore itself is somewhat funnel-shaped immediately below the sporangium and beyond this portion, which is known as the *apophysis*, is the hemispherical, sometimes almost spherical, bladder-like *columella* (Fig. 6), which is the sterile swollen end of the sporangiophore lying within the sporangium. On drying the columella collapses and assumes an umbrella-like form as shown in Fig 5. The wall of the sporangium is very easily ruptured and spores are liberated immediately on merely placing a sporangium in a drop of water. The dark-coloured spores vary in size but may reach a diameter of about 15μ.; they are irregular in shape, and the spore wall is provided with numerous fine ridges, which are most easily seen when the spores are dry.

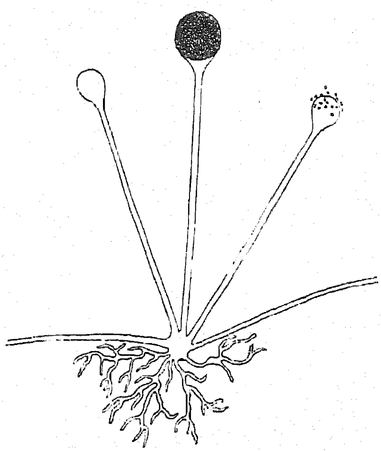


Fig. 6.
A group of three sporangiophores; one bears a sporangium still intact; the other two show the columella after dispersal of the spores.

In addition to such spores produced in sporangia *Rhizopus nigricans* produces thick-walled resting spores, known as *zygospores*. Prof. Blakeslee, of Harvard University, has shown that this species comprises two forms which are practically indistinguishable from one another in appearance, and

that the zygospores are produced only when the two strains, known as the (+) and the (—) forms are growing together; each zygospore is the result of a protoplasmic and probably a nuclear fusion at places where hyphæ of the two forms come in contact with one another. No zygospores have yet been found on the material at Wye, and since all the cultures were derived originally from a small portion of mycelium obtained from a diseased tomato it is to be presumed that they are all of one strain, but whether (+) or (—) has not yet been ascertained.

On enquiry it was found that the tomatoes sent to the College had been imported from the Canary Islands, and were part of a consignment, of which it was said that about ten per cent. were unsaleable. It is an interesting fact in this connection that the optimum temperature for *Rhizopus nigricans*, *i.e.*, the temperature at which it grows most vigorously, is from 30° C. to 37° C. (86° F. to 90° F.), and since all the experiments, with the exception of the plate culture, which was kept at a temperature of 26° C., were carried out at the ordinary temperature of the laboratory, about 16° C. (60° F.), it is probable that in a country warmer than our own the rot would be much more rapid. If the tomatoes are packed, in the Canaries for example, even before the rot is outwardly visible, it is highly probable that some would be completely destroyed before reaching our shores.

As sound tomatoes may remain in contact with infected ones without contracting the rot, it would seem that to pack among a large number of sound tomatoes a few which were cracked, little harm would be done, even though *Rhizopus* spores were present in the cracks at the time of packing. The great danger appears to be, however, that the fleshy parts of the tomatoes attacked by *Rhizopus nigricans* are reduced to a watery pulp, while the skin, in consequence, becomes quite flaccid and is ruptured by the mere weight of its contents. Each tomato, as it collapses, leaves in the box a space which allows of a certain amount of movement of those tomatoes in the vicinity and in all probability this would lead to bruises and cracks in fruit which were quite sound when packed. Meanwhile the slimy liquid liberated would behave as a nutrient substratum and, flowing among the other fruit,

would induce the fungus to spread rapidly throughout the box.

Jelliffe* has shown that *Rhizopus* spores are often floating in the air and it is a matter of general observation that vegetable matter exposed to the air often becomes contaminated by this fungus. It is advisable, therefore, that discarded tomatoes and other vegetable refuse be not allowed to accumulate when the packing is done, because *Rhizopus* spores falling on such material would immediately germinate and produce in a very short time a rich crop of spores which would be set free into the air.

The boxes themselves may in some cases serve as the source of infection, since the spores could easily find a lodging in any small crevice of the wood, and cause infection of fruit which became injured during the packing or during the voyage. Massee† found that packing-cases served as a source of infection in the case of the Cucumber Leaf Blotch (*Cercospora melonis*).

Wrapping the tomatoes in tissue paper, as is commonly done, will not save them if once the rot begins, for the paper becoming impregnated with the liberated juice, is not only easily torn, and therefore useless, but serves as a culture medium for the fungus.

Apparently the pest is not a serious one in this country except on imported tomatoes, but those growers who cultivate the tomato on a large scale should look upon *Rhizopus nigricans* with suspicion.

* *Jelliffe, S. E.*, "Some Cryptogams found in the Air" (Bullet. of the Torrey Botan. Club, 1897).

† *Massee, G.*, "Diseases of Cultivated Plants and Trees," p. 485.

A NEW DISEASE OF APPLE BUDS.

By E. S. Salmon and H. Wormald.

(Plates XXIV. & XXV.)

For several past seasons Mr. Arthur Miskin, of Ladds Court, Chart Sutton, has observed that in one part of his plantation many of the flower buds of certain apple trees failed to develop, and remained as unopened buds throughout the flowering season until they finally dropped to the ground. The diseased buds are noticeable only by the contrast when the normal healthy ones swell and burst into bloom ; before that time the two kinds are practically indistinguishable (see Plates XXIV. and XXV.).

The affected trees are about eighty Grenadiers and a few Bramley's Seedlings; last year (1912) the former had numerous diseased buds, amounting to over fifty per cent. on some of the boughs, while on the latter variety comparatively few were to be found. This year the percentage of diseased buds on the two varieties is approximately as last year. Although the healthy buds develop in the usual way the crop produced by the affected trees is below the average owing to the large proportion of bloom buds killed. The disease has not been observed on Grenadiers in other parts of the plantation until this year, when a few dead buds were found on young trees seven years old.

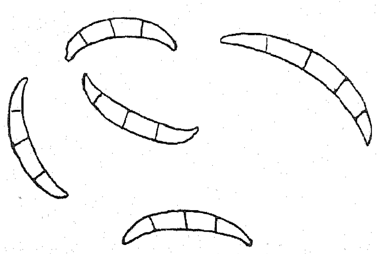


Fig. 7.
Conidia from *Fusarium* associated with the Apple-bud Disease. × 540.

Diseased buds have been examined on several occasions during 1912 and 1913, and the microscope has revealed the constant occurrence of a fungal

mycelium among the bud-scales. Conidia produced by this mycelium are of the shape found in *Fusarium* and small *sporodochia* (*stroma*-like masses of densely interwoven fungal hyphæ producing the *conidia* on the surface) have been found. No other type of spore has been found in buds taken from the tree; on material which has been kept in the laboratory for some weeks various saprophytic fungi developed on the dead tissues. In a few cases bacteria have been observed in the gummy fluid which often oozes from the brown dead cells of the bud-scales when placed in water. The species of *Fusarium* associated with this disease has not yet been determined; the conidia are curved, pointed at each end, usually three-septate when mature, and measure 25 to 35μ by 3.5 to 4.5μ (see Fig. 7).

The disease apparently does not extend beyond the base of the bud and no "cankers" have been observed associated with the dead buds. In Apple "canker," caused by *Nectria ditissima*, the conidial or summer stage of which is a *Fusarium*, "cankers" frequently occur near the bud. The fungus found on the diseased buds differs from the conidial form of *Nectria ditissima* in the fact that the conidia are smaller, more curved, more pointed at the extremities, usually three-septate and measure 25 to 35μ by 3.5 to 4.5μ; the conidia of *Nectria ditissima* are rounded at the ends, are usually five-septate and measure 35 to 60μ. by 4.5 to 5μ (see Fig. 8).

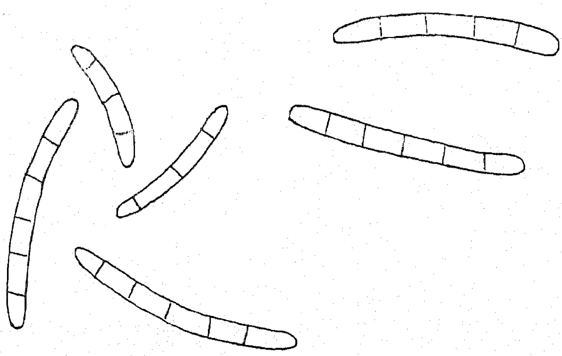


Fig. 8.
Conidia of *Nectria ditissima* × 540

THE LIME-SULPHUR WASH FOR AMERICAN GOOSEBERRY MILDEW.

(*Sphaerotheca mors-uvae*).

BY E. S. SALMON AND C. W. B. WRIGHT.

In the last number of this *Journal*, an account was given of some experiments carried out during 1911 at the South-Eastern Agricultural College, Wye, Kent, with the object of ascertaining at what strength (specific gravity) the lime-sulphur wash can be used on the foliage of the gooseberry, without causing injury. The general conclusions arrived at were summarised as follows :—

"(1) It appears safe, under any weather conditions, to spray 'Whinham's Industry' with the lime-sulphur wash at 1.005 sp. gr. Probably it is safe under most weather conditions to spray this variety with the wash at 1.01 sp. gr.

"(2) It is unsafe, during very hot weather, or if very hot weather is expected, to spray 'Berry's Early' (and probably 'Yellow Rough') with the wash at 1.005 sp. gr. (or even at a lower concentration), as serious defoliation will result.

"(3) In dull, warm weather, and in sunny weather if it is not exceptionally hot, it appears safe to spray 'Berry's Early' with the lime-sulphur wash at 1.005 sp. gr., as only very slight defoliation will result.

In the same article the advantages of the lime-sulphur wash, as a sulphur wash which is not readily washed off by rain, were pointed out, and reference may be made to this article for information on this point, particularly in connection with the control of American Gooseberry mildew. The prediction that, as a factory-made concentrated lime-sulphur wash at a guaranteed specified gravity was being placed on the English market by firms of repute, this wash would be given an extensive trial, has proved correct; inquiries have been

and are being constantly received from growers asking for advice as to the use of the lime-sulphur wash on gooseberries.

During the season of 1912 further experiments were carried out. These experiments—as can be seen by the details given below—show very clearly that the different varieties of gooseberries cultivated commercially in this country differ to a marked degree as regards their susceptibility to injury from the lime-sulphur wash; further, that on certain varieties it is possible to use the wash at a strength (specific gravity) sufficient to prevent the attacks of American Gooseberry-Mildew without injury to foliage.

The experiments in 1912 were carried out on certain fruit-farms in the Swanley district, North Kent, through the courtesy of Messrs. Wood, Staples, Langlands and Conford. The actual spraying was carried out by Mr. C. W. B. Wright; in all, 1,015 bushes of nine different varieties of gooseberries were sprayed. The Vermorel "Eclair" knapsack sprayer was used, with a nozzle giving a very fine "misty" spray. In every instance the bush was sprayed thoroughly—in the case of the larger bushes about 3 gallons of wash were used for 20 bushes; in the case of the smaller bushes 3 gallons sufficed for 50 bushes. It will be most convenient to record the results obtained under each variety of gooseberry.

Warrington.—The bushes used were old, and consequently produced little fresh growth; they were growing under standard apple trees and were thus to some extent shaded. The lime-sulphur wash was used at 1.01 sp. gr. The first spraying was given on April 29th, when twenty bushes were sprayed. There was no injury noticeable when the bushes were examined on May 6th and May 11th. The same bushes were sprayed a second time on May 11th. There was again no injury, and the bushes were sprayed for the third time on May 25th with the same result. During all this period the weather was very dry; there was no hot sunshine, the sky being usually overcast.

The experiment was repeated with twenty fresh bushes of the same variety, spraying being carried out three times—on June 17th, June 28th, and July 12th—with the wash at the same strength. The object of this experiment was to ascertain if susceptibility to injury varied at different times in the

season. No injury was caused, although a spell of very hot weather occurred at this time.

It seems safe to conclude that Warringtons, when the bushes are old and in a somewhat shaded position, may be sprayed from May to July, under ordinary summer conditions, with the 1.01 wash without fear of injury to the foliage, even when three sprayings are given.

Valentine's Seedling.—These bushes were similarly situated to the Warringtons, under standard plum trees. A lime-sulphur wash of the same strength (1.01 sp. gr.) was applied on the same day, *viz.*, April 29th—ten bushes being sprayed. When the bushes were examined on May 6th and May 11th, only a very slight leaf-fall had occurred; there was no appreciable damage caused at this date. A second spraying of the bushes was given on May 11th; and when the bushes were examined on May 18th it was found that a considerable leaf-fall had occurred. The bushes were sprayed a third time on May 25th; when examined on June 1st it was found that the damage (in the form of leaf-fall) was so considerable that it was considered inadvisable to continue using the wash at 1.01 sp. gr.

On June 17th ten fresh bushes were sprayed with the wash at 1.005 sp. gr. A marked leaf-fall resulted, the injury produced being greater than that caused in May by the wash at 1.01 sp. gr. A second spraying was given on June 28th; so much injury (in the form of leaf-fall) resulted that it was decided to discontinue the use of the wash at 1.005 sp. gr.

An experiment with the wash at 1.0025 sp. gr. was carried out on July 12th, when ten further bushes were sprayed. When examined on July 26th, these bushes were found to be so injured as to be almost defoliated. The weather during this time was very hot.

It would appear that Valentine's Seedling exhibits considerable susceptibility to injury from the lime-sulphur wash, and that this susceptibility increases in a marked manner during the season. It is doubtful if, after the middle of May, the lime-sulphur wash can be used with safety on this variety.

Whinham's Industry.—The bushes used were similarly

situated to the two preceding varieties, and were sprayed under the same conditions. A control experiment was also carried out with bushes in a sunny position. In each case twenty bushes were sprayed with the 1.01 sp. gr. wash three times, *viz.*, on April 29th, May 11th, and May 25th. No injury resulted in any case.

The experiment with the bushes in a sunny position was repeated later in the season, twenty fresh bushes being sprayed with the 1.01 sp. gr. wash three times, *viz.*, on June 17th, June 28th and July 12th. No injury resulted. In order to test still further the non-susceptibility of this variety to spray-injury, the same twenty bushes were sprayed a fourth time on July 26th, and again no damage was caused.

It appears, therefore, that under ordinary summer weather conditions, Whinham's industry may be repeatedly sprayed throughout the season with the 1.01 sp. gr. wash without fear of injury.

Lancashire Lad.—As this variety is probably the one grown to the greatest extent in North Kent, it was considered advisable to test its susceptibility to injury by spraying under different conditions.

In the first experiment, the twenty bushes, about four years old and not very robust, were in a shaded position; the wash was used at 1.01 sp. gr. The first spraying was given on April 29th, and the bushes when subsequently examined showed no appreciable injury. The bushes were again sprayed on May 11th; it was found later that the wash had clearly had an injurious effect, as a considerable number of leaves were turned yellow, and some of these fell. A third spraying was given to the bushes on May 25th; this time the injury resulting was so great that further spraying of this variety with the 1.01 sp. gr. was discontinued.

In another experiment carried on during May and June only one spraying with the 1.01 sp. gr. wash was given to the bushes. The bushes used were healthy, about five years old, and situated in a shady position. No injury followed any of the sprayings, while, as noted above, bushes (slightly younger and not so robust) were almost defoliated after three sprayings. It was also noticed that two bushes, growing among another variety in a sunny position, were similarly

almost defoliated after one spraying with the 1.01 sp. gr. wash at this time of year.

In a further experiment the bushes, which were about five years old, were situated in a sunny position. The 1.005 sp. gr. wash was used. The first spraying was given to twenty bushes on June 17th, in dull weather; the bushes were sprayed again on June 28th, in bright sunshine, and for the third time on July 12th, also in bright sunshine. Some damage was noticeable, in the form of a slight leaf-fall, after the first spraying, but the control bushes were found to be losing their leaves to the same extent. No further leaf-fall occurred after the second or third sprayings.

It seems safe to conclude that Lancashire Lad may be sprayed with the 1.005 sp. gr. wash under ordinary summer conditions; and that probably a single spraying with the 1.01 sp. gr. wash may safely be given early in the season and when the bushes are shaded.

Berry's Early.—As in previous experiments, this variety had shown a marked susceptibility to spray injury, the wash was used first at 1.005 sp. gr. In the first experiment twenty large bushes, from ten to fifteen years old, were sprayed; all but two of these bushes were in a shaded position. The first spraying was given on April 29th, and no injury resulted except on the two bushes in a sunny position, which lost a considerable number of leaves. A second spraying was given these twenty bushes on May 11th, and a third spraying on May 25th. No injury resulted, except on the two bushes in the sunny position, which continued to show a leaf-fall.

In the next experiment the bushes, which were about five years old, were situated in a sunny position. Twenty bushes were sprayed on June 17th with the 1.005 wash. The sprayed bushes subsequently showed a slight leaf-fall, but it was found that the control bushes had also dropped some of their leaves—just as had happened with Lancashire Lads at the same time of year (see above). The twenty bushes were again sprayed on June 28th, and a more pronounced leaf-fall was caused, the leaf-fall from the sprayed bushes being decidedly greater than that from the unsprayed "control" bushes. The same twenty bushes were sprayed a third time

on July 12th, and a week later the leaf-fall had been so considerable that the bushes were now almost defoliated.

On July 26th another experiment was started; twenty fresh bushes in a sunny position were sprayed with the 1.0025 sp. gr. wash. The leaf-fall resulting was again considerable.

It may be concluded that early in the season bushes of Berry's Early growing in somewhat shaded positions may safely be sprayed with the 1.005 sp. gr. wash; it is certain however, that later in the season, and under certain weather conditions, the wash at this, and even at a lower concentration, will cause serious injury.

Crown Bob.—These bushes, which were old, were situated in a sunny position. In the first experiment twenty bushes were sprayed three times with the 1.01 sp. gr. wash; the spraying was done on April 29th, May 11th, and May 25th. A few bushes here and there dropped a few leaves, but the injury caused by the three sprayings was not appreciable.

The experiment was repeated on June 17th and June 28th. After the second spraying a very considerable leaf-fall occurred, but, contrary to usual experience, not until the tenth day after the spraying; on the ninth day a thunderstorm occurred, followed by hot sunshine, and the next day the bushes were found to be nearly defoliated.

A fresh experiment was carried out, using the 1.005 sp. gr. wash. The bushes, twenty in number, were sprayed on July 12th and again on July 26th. Although the spraying caused a few leaves to fall, the injury resulting was certainly not appreciable.

Although further experiments are necessary to obtian definite information, it appears that quite early in the season the 1.01 sp gr. wash may be used for Crown Bob, but that later in the season the wash at this strength causes defoliation, and that therefore after May or early June the 1.005 sp. gr. wash should be used.

Rifleman.—The twenty bushes sprayed with the 1.01 sp. gr. wash were old, and were situated in a sunny position, and the first spraying was given on April 29th. The bushes were again sprayed on May 11th and on May 26th, but all remained absolutely unaffected by the spray. The experiment was repeated with twenty fresh bushes, which were sprayed on

June 17th, June 28th and July 12th, and the result was the same.

It may therefore be concluded that old bushes of Rifleman can safely be sprayed at least three times with the 1.01 sp. gr. wash throughout the summer ; it has yet to be proved whether young actively growing bushes show the same non-susceptibility.

Yellow Rough.—As this variety had previously been found to be susceptible to spray-injury, the wash was used at 1.005 sp. gr. in the first series of experiments. All the bushes used were in a shaded position, and in each experiment most of the bushes were fully-grown, ten to fifteen years old, while a few were young, about four years old. Ten bushes were sprayed on May 1st, and a considerable leaf-fall resulted. These bushes were again sprayed on May 11th, and on May 18th the injury was found to be so severe that it was obviously useless to continue using the wash at this concentration.

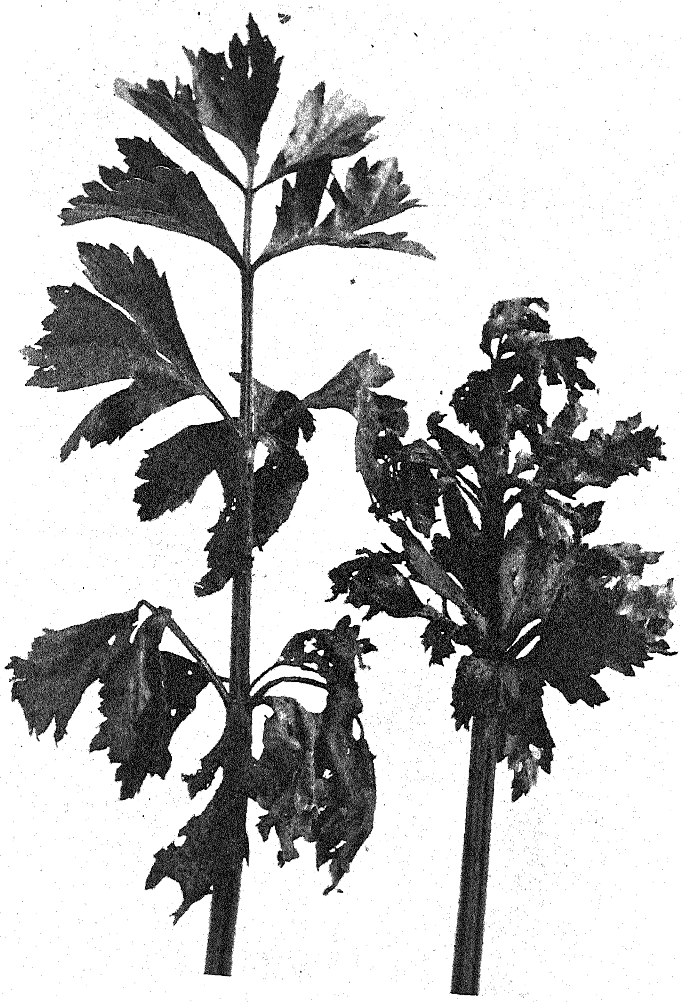
In the second experiment five fresh bushes were sprayed with the 1.0025 sp. gr. wash on June 28th, and on July 5th no injury was noticeable ; but on July 12th the bushes were found to be almost defoliated.

A third experiment was then carried out, using the wash at 1.001 sp. gr. Five fresh bushes were sprayed on July 26th, and again a marked leaf-fall resulted.

It is clear, therefore, that Yellow Rough, even when growing in a shaded position, is very susceptible to injury from the lime-sulphur wash. As early in the season as May this wash cannot be used at " half-strength " (1.005 sp. gr.) without causing serious injury. Later in the season the wash at 1.001 sp. gr. is decidedly injurious. The lime-sulphur wash, in its present commercial form, must therefore be considered as entirely unsuitable for such varieties as Yellow Rough.

May Duke.—With this variety an opportunity was obtained of testing both its susceptibility to spray-injury from lime-sulphur, and the value of this wash in preventing the spread of American Gooseberry-Mildew. The twenty bushes sprayed, about seven years old, were situated in a single row under standard apple trees, and were rather densely shaded.

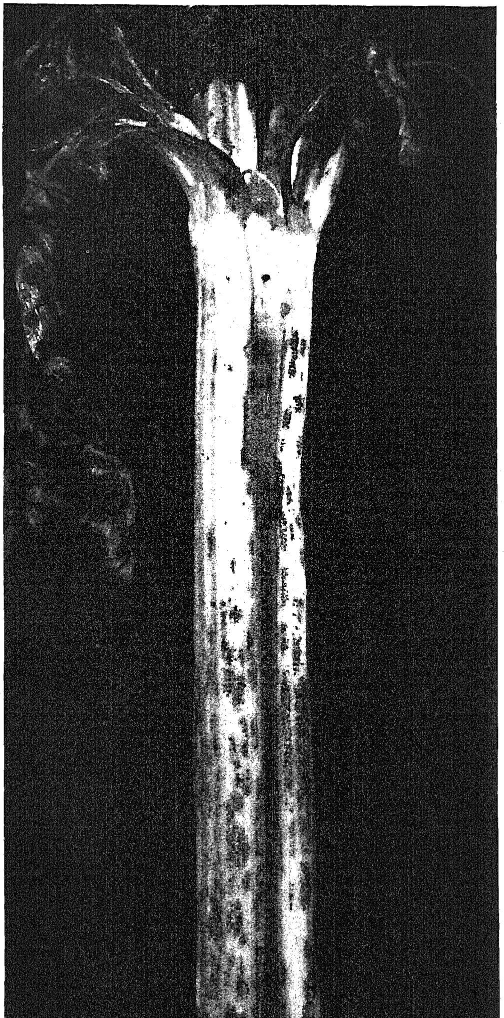
PLATE I.



Celery affected by "blight."

[W. H. Hammond, photo.

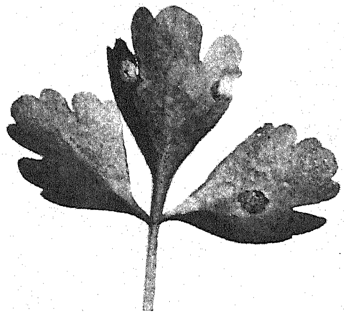
PLATE II.



[*H. Wormald, photo.*

Leaf-stalk of a Celery plant affected with "blight." The numerous minute black fruit-conceptacles (*pycnidia*) of the fungus *Septoria* can be seen on its surface.

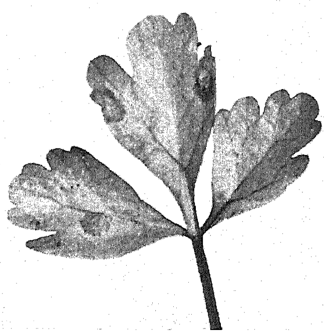
PLATE III.



[H. Wormald, photo.

Leaf of a seedling Celery-plant, showing three spots of disease. (Natural size.)

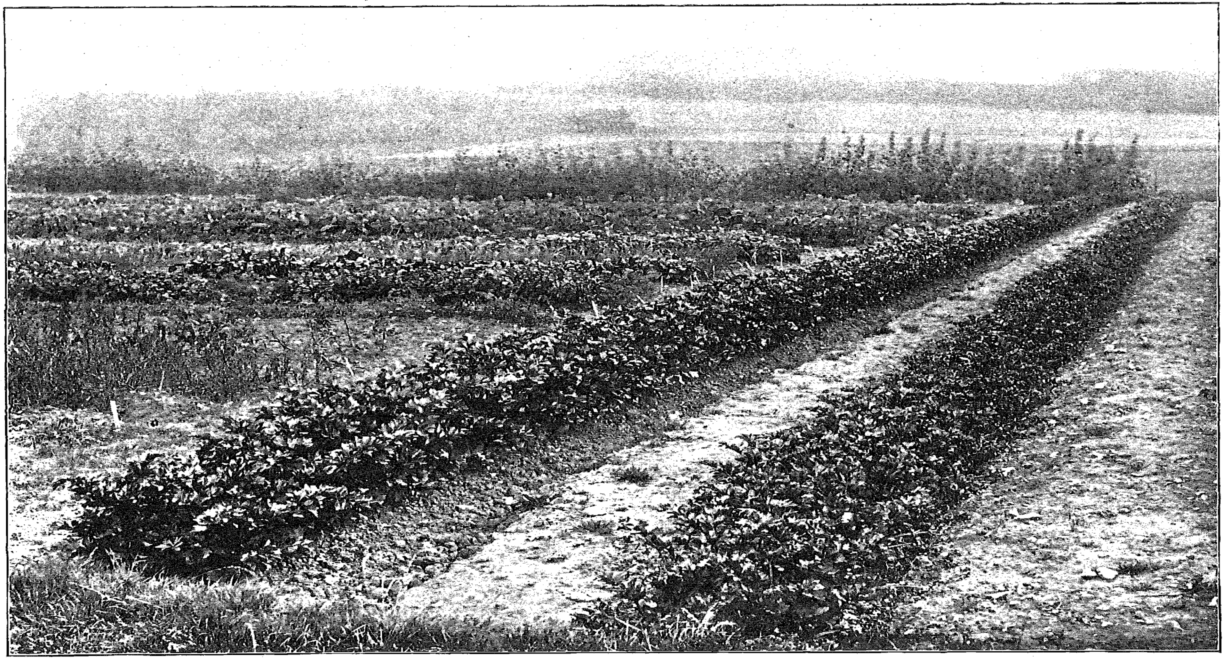
PLATE IV.



[H. Wormald, photo.

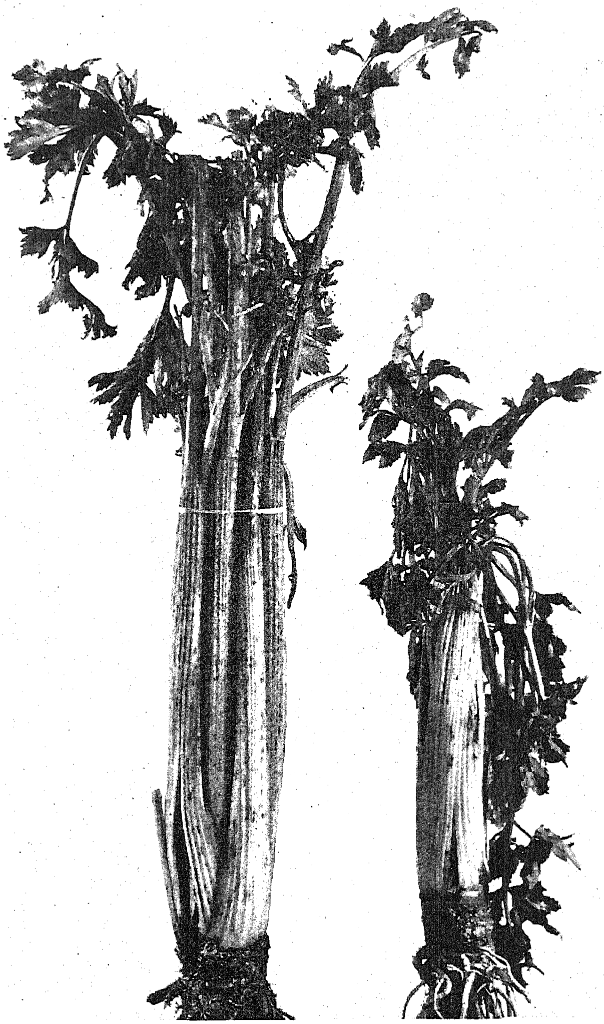
Under-surface of the leaf shown in Plate III.

PLATE V.



General view of the sprayed row (to left) and unsprayed row (to right) of Celery (see page 336).

PLATE VI.



[*H. Wormald, photo.*

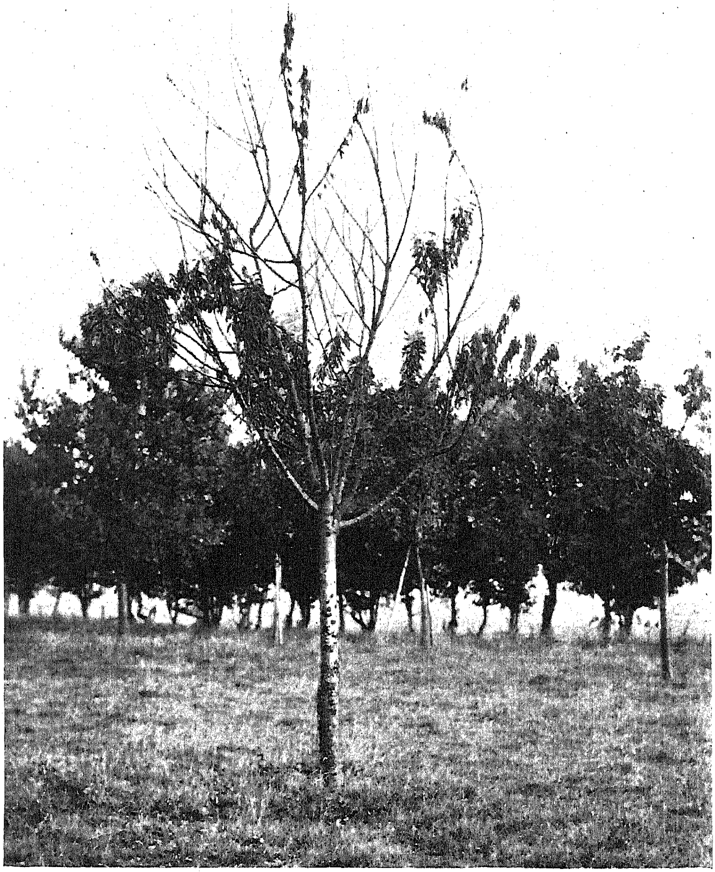
Celery plants from the sprayed and the unsprayed rows (see p. 336).

PLATE VII.

[H. Wormald, photo.

Diseased Cherry Tree in an orchard where sheep are allowed to graze. A few dead branches are seen.

PLATE VIII.



[*H. Wormald, photo.*

Diseased Cherry Tree in the same orchard as the tree shown in Plate VII. *Cystospora* pustules were found on the trunk and branches, at the time when the photograph was taken.

PLATE IX.

[H. Wormald, photo.

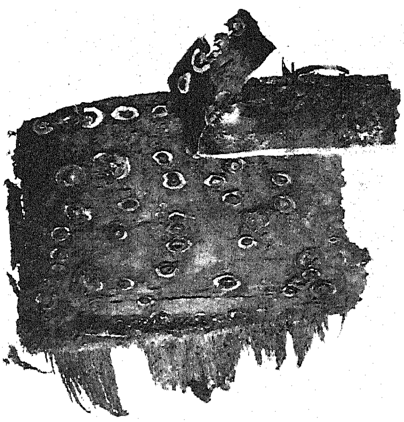
Diseased Cherry Tree in a plantation with mangolds. A few branches are dead.

PLATE X.

[H. Wormald, *photo*.

Diseased Cherry Tree in the same plantation as shown in Plate IX. *Cytospora* pustules were found on the dead branches and on the upper part of the trunk.

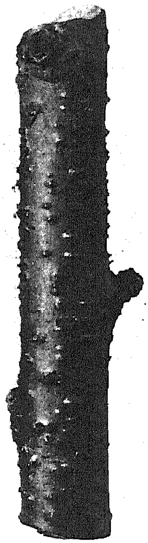
PLATE XI.



[*H. Wormald, photo.*

Portion of bark of diseased Cherry Tree; stromata of *Cytospora* exposed by stripping away the outer layer of the bark.

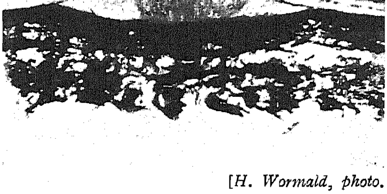
PLATE XII.



[H. Wormald, photo.

Pustules of *Cytospora* on a diseased branch. "Tendrils" may be seen on the left.

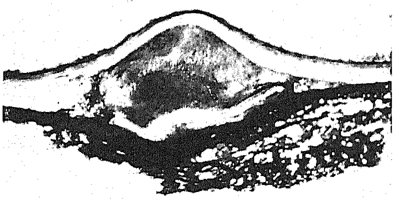
PLATE XIII.



[H. Wormald, photo.

Cytospora leucostoma. Section through young stroma. × 24.

PLATE XIV.



[H. Wormald, photo.

Cytospora leucostoma. Section through older stroma, which, however, has not burst through the bark. × 24.

PLATE XV.

[H. Wormald, photo.

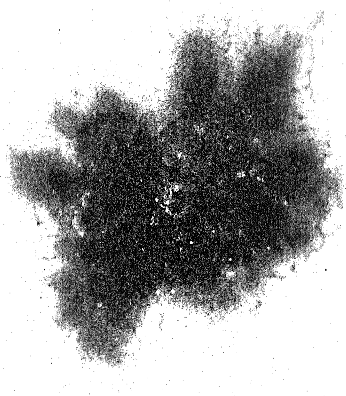
Cytospora leucostoma. Section through mature stroma. × 24.

PLATE XVI.

[H. Wormald, photo.

Cytospora leucostoma. Section through the base of a stroma, showing cortical cells embedded in the fungal hyphæ. × 110.

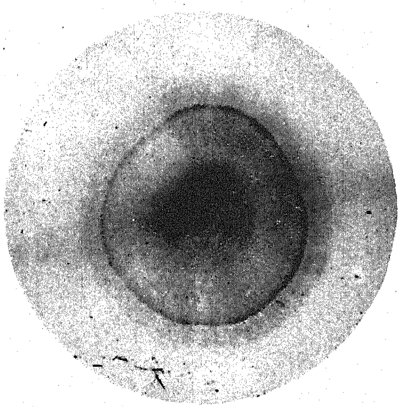
PLATE XVII.



[W. H Hammond, photo.

Cytospora leucostoma. Culture on prune-juice agar.

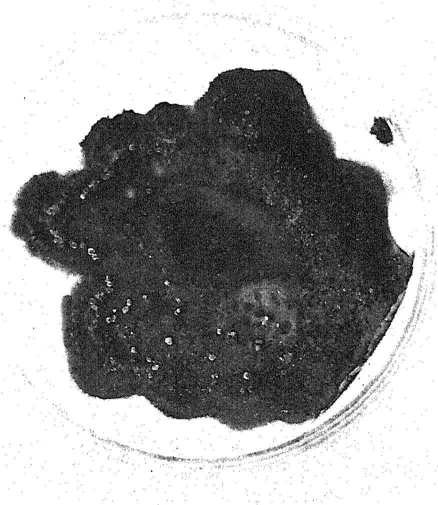
PLATE XVIII.



[W. H. Hammond, photo.

Cytospora leucostoma. Culture on sugar-beet agar.

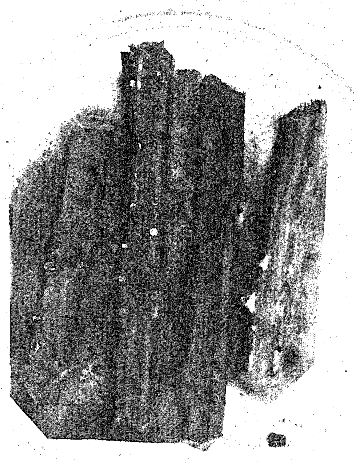
PLATE XIX.



[W. H. Hammond, photo.

Cytospora leucostoma. Culture started on prune-juice agar, and after nine days covered with a layer of sugar-beet agar; numerous fructifications (stromata) are to be seen.

PLATE XX.



[W. H. Hammond, photo.

Cytospora leucostoma. Culture on sterilized pieces of cherry twigs.

PLATE XXI.

[W. H. Hammond, photo.

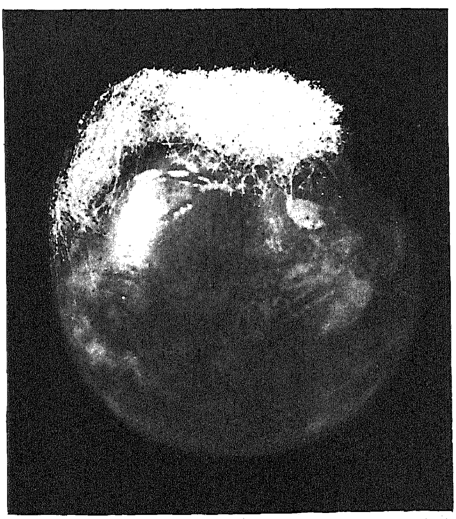
A fructification with a "tendril," from the culture shown on Plate XX.

PLATE XXII.

[W. H. Hammond, photo.

Conidia (× 1000) obtained from a tendril produced on the culture shown on Plate XX.

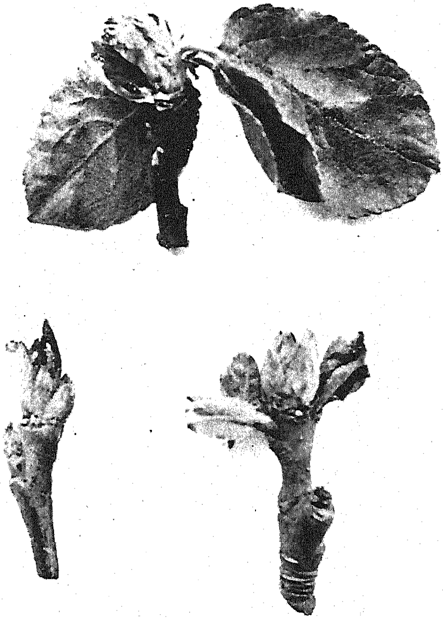
PLATE XXIII.



[H. Wormald, photo.

A tomato ten days after inoculation with *Rhizopus nigricans*.

PLATE XXIV.



[F. Edenden, photo.

Three dead Apple-buds containing mycelium of *Fusarium*.

PLATE XXV.

[F. Edenden, photo.

Twig of Apple, showing in the lower part two dead buds containing mycelium of *Fusarium*.

On either side of the row and at one end was a plantation of exactly similar bushes, and at the time of the beginning of the experiment all the bushes were more or less affected with the winter stage of the American Gooseberry-Mildew, which had severely attacked the whole plantation the previous summer. The object of the experiment was to ascertain if it was possible, by the use of lime-sulphur at a strength not injurious to the foliage, to keep these twenty bushes free from the mildew. The conditions—*viz.*, the crowded position of vigorously growing bushes in a shaded position, with the consequent comparative lack of ventilation—were such as to favour the rapid spread of the mildew when it appeared. The wash used was of 1.01 sp. gr. The first spraying was given on May 1st, the second on May 11th, the third on May 25th. No injury was produced. After the third spraying American gooseberry-mildew appeared on bushes in several adjacent rows of the surrounding plantation. The berries were picked from the bushes in the infested parts of the plantation on June 1st, and it was estimated that one-sixth part of the crop was more or less affected with the mildew. No mildew appeared on the berries of the sprayed bushes. The bushes were sprayed for the fourth time on June 12th, when there was still no sign of mildew on them. A fifth spraying was given on June 28th, on which date two leaves were found on a bush in the sprayed row with the mildew just beginning to develop, these leaves being on the tips of shoots which had grown away from the sprayed part. All the twenty bushes in the row were sprayed for the sixth time on July 12th—at which date no mildew could be found on them. The sprayed bushes were kept under observation throughout August, and no further spraying was necessary. At the end of August the sprayed bushes were all entirely free from American Gooseberry Mildew, while the bushes in the contiguous and adjacent rows, and throughout the plantation generally, were plentifully infested along the young shoots with the brown " winter-stage " of the mildew, in spite of the fact that these bushes had been " tipped " three times.

In order to determine if bushes of this variety might safely be sprayed when in a sunny position, twenty bushes so situated were sprayed three times in the sunshine, *viz.*, on

June 17th, June 28th, and July 12th, the 1.01 sp. gr. wash being used. There was no leaf-fall or other injury.

It is clear, therefore, that May Duke can safely be sprayed with the 1.01 sp. gr. wash, even when six consecutive sprayings are given. Further, the experiments show that under cultural conditions—closely-planted, vigorously-growing bushes in a shaded and shut-in position—and under weather conditions favourable to the spread of the American Gooseberry Mildew (such as obtained during the summer of 1912) the lime-sulphur wash at 1.01 sp. gr. is able to protect bushes from the spread of the disease.

Some further points of great practical importance have still to be determined. Firstly, how many sprayings are necessary in order to prevent infection with the American mildew and the formation of any "winter-stage" on the shoots; also, if six sprayings are necessary, is the cost prohibitive for commercial purposes? With regard to the first point, the number of sprayings necessary will be to a large extent determined by the vigour of growth of the bush; as long as fresh shoots are being formed, sprayings at intervals of about ten to fourteen days must be given to prevent these shoots from becoming infected—the assumption being made that the bushes are exposed to infection from air-borne spores (*conidia*) produced in neighbouring plantations. In this connection it must be pointed out that the bushes should be sprayed (as in the above experiment) *before* any infection by "winter-spores" (*ascospores*) has taken place; the first spraying should therefore be given early in May. Owing to the cheapness of the lime-sulphur wash, and the ease of application, there seems little doubt that even if six sprayings are necessary the cost of the treatment will not be an excessive charge on the profits of a well-kept gooseberry plantation.

Another most important point to be considered is the effect of the spray in preventing the marketing of the berries. The lime-sulphur wash after exposure to the air deposits a conspicuous whitish dust-like powder over the sprayed parts; this consists of very minute particles of sulphur, which are remarkably adhesive and are not readily washed off by rain or dew. The fruit on recently sprayed bushes cannot therefore be marketed.

An important fact observed last year in connection with the susceptibility of the berry has, however, to be considered here. It was found that at a certain stage of development the fruit of *Cousin's Seedling* (*Sandwich Yellow*) becomes immune to attacks of the mildew. In the cases observed, an attack of mildew was noticed on the bushes of a plantation of this variety at the time when the berries were about half developed. All the bushes were gone over by hand, and every mildewed berry gathered and destroyed. These mildewed berries formed perhaps five per cent. of the crop. Although subsequently the mildew increased noticeably on the young shoots during the following weeks, the developing berries left on the bushes proved quite resistant and when ripe showed no mildew. The fact of this immunity of the berry to mildew at a certain stage of growth suggests that, with some late-ripening varieties, such as *Cousin's Seedling*, it may prove profitable to spray infested bushes with lime-sulphur during the short time when the young berries are susceptible, and then leave off spraying during the comparatively long time when the berries, now immune, are gradually ripening—in which case the amount of spray to be found on the fruit when ready for market would be negligible.

In cases where valuable plantations of choice varieties of gooseberries have become badly infested with the mildew, it might prove worth while to sacrifice the crop for one year if the measures taken ensured that the disease would be practically eradicated—always supposing that no danger exists of such plantations being re-infected the next season from an outside source.

Conclusions.—Different varieties of gooseberries differ to a marked degree as regards the susceptibility of the foliage to injury from the lime-sulphur wash. It is possible with some varieties, *e.g.*, May Duke, to spray repeatedly throughout the season with lime-sulphur, at a strength (1.01 sp. gr.) sufficient to prevent the attacks of American Gooseberry Mildew, without causing any injury to the foliage. It seems probable that, at least with some varieties, the young foliage at the beginning of the season (May) will prove resistant to injury from the lime-sulphur wash, while showing susceptibility later in the season. This is important from the practical standpoint

of keeping down the disease, since it is during May and early June that spraying will prove most efficacious in preventing the first infection in the season by germinating "winter-spores" (*ascospores*) and the rapid spread of the mildew by the first-formed "summer-spores" (*conidia*). Under ordinary summer weather conditions the "strength" of the lime-sulphur wash should be as follows :—

For *Whinham's Industry, Rifleman, Warrington* and *May Duke :* 1.01 sp. gr.

For *Lancashire Lad :* 1.005 sp. gr.

For *Crown Bob :* 1.005 sp. gr. early in the season ; later in the season some injury may be caused.

For *Berry's Early :* 1.005 sp. gr. early in the season and when the bushes are more or less shaded ; later in the season injury is caused by the wash at this, and at lower, concentration.

For *Valentine's Seedling* and *Yellow Rough :* these varieties show so marked a susceptibility to injury that they cannot safely be sprayed with lime-sulphur.

For the present—until further experiments have been carried out—the "half-strength" wash (1.005 sp. gr.) should be used (except where indicated above) and the spraying done on an experimental scale.

NOTES ON HOPS.

BY

E. S. SALMON, F.L.S.

NOTES ON HOPS.

By E. S. Salmon, F.L.S.

1.—On the Raising of New Varieties from Seed.

The work of "crossing" different English and foreign hops, with the object of obtaining new varieties, was continued through 1911. The female parents used for "crosses" were:—Canterbury Whitebine; four Seedling hops (raised previously) of the following parentage,—Cobb's Golding $\times$ early-flowering, red-bined male ((*Ref. No.* I 14); Colegates $\times$ male growing among Canterbury Whitebines (*Ref. No.* G 21) (see this *Journal*, Vol. XIX., p. 370 and Vol. XX., p. 461); "Hammond Wild Hop"* $\times$ green-bined male (*Ref. Nos.* 114 and 120); and two German varieties, Elsass and Late Bavarian (hops from which have shown a high percentage of resins, see this *Journal*, Vol. XIX, p. 380). These female hops were "crossed" with various selected English, German and Oregon male hops.

Seed was also collected for sowing from the following hops: seven Seedling hops (raised previously) of various parentage; the German varieties, Upper Bavarian and Late Bavarian, and the Oregon "Cluster" hop, obtained in 1908 through the kindness of Messrs. Wigan, Richardson & Co. Further, Dr. J. Schmidt, of the Carlsberg Laboratory, Copenhagen, has supplied us with seed obtained by "crossing" the "Asperup" hop—one of the varieties grown in Denmark—with a green-bined male (*Ref. No.* G 27) growing in our experimental hop garden, "pollen" from this having been sent out to him.

As pointed out in previous numbers of the *Journal*, we have now a number of promising "seedling" hops available for trial by hop-growers in Kent, Surrey or Sussex. Many of these seedlings have obtained a favourable report in the Borough as to their flavour, and show on chemical analysis a

* See this *Journal*, Vol. XIX., p. 373.

high percentage of soft resins. Their cropping power now remains to be tested on the various soils in the counties.

During the season of 1911 several hop-growers visited the College hop "nursery" and selected new "seedling" hops for testing in the soil of their own hop-gardens. "Cuts" from these selected hops were sent to the grower the following autumn. In all 899 "cuts" of sixteen different varieties were sent out to nine growers at Chilham, Maidstone, Maplescombe, Brenchley, Goudhurst, Paddock Wood and Benenden.

The College hop "nursery" is open to inspection at any time by hop-growers in Kent, Surrey or Sussex.

During 1911, as in previous seasons, hops from selected "seedlings" and from various English and foreign varieties growing in the College experimental hop-garden were picked and dried, and box samples submitted to factors and merchants in the Borough. The reports obtained as to flavour are given below, together with notes on the character of growth shown by the respective plants.

CLASS I.—OF UNKNOWN PARENTAGE; BELIEVED TO BE "SEEDLINGS."*

† Indicates that a sample of this hop was submitted to factors in previous seasons (see this *Journal*, Vols. XIX. and XX.).

†*Ref. No.* B 7.—Very vigorous and fruitful; bine striped; hops thick, green, or, in some seasons, with a tinge of red.

1911.—"A nice hop with Golding flavour, should place it third in this class" (Factor B); "Golding flavour, should place it second, or perhaps equal to F 1" (Factor A).

†*Ref. No.* B 9.—Fairly vigorous and fruitful; red bine; early-medium; hop very large and long, occasionally "leafy."

1911.—"Nothing in it; does not appeal to me" (Factor B); "Nothing holding in it; almost flavourless" (Factor A).

†*Ref. No.* B 10.—Vigorous and fairly fruitful; green bine; early medium; hop rounded, thick.

1911.—"Not a pleasing flavour." (Factor B).

* For the soft resins contents of these hops, see the Table at p. 417.

†*Ref. No.* B 18.—Vigorous and very fruitful; striped bine; late hop; laterals of medium length; hops thickly set; hop oval, rather small.

1911.—40½ bushels of hops were picked from thirty-five hills of this variety (planted from "cuts" in 1908-9); the hops were dried separately and put into a pocket. An ordinary commercial sample was submitted to Factors. "A very nice flavour, inclined to the Colegate; a good hop" (Factor B); "Is not a true Colegate, but has a ranker flavour, probably belongs to the Colegate class" (Factor A); "Has strong but *not coarse* flavour" (Factor D).

†*Ref. No.* B 20.—Vigorous and fruitful; green bine; very early; hop large, thick, green.

1911.—"Golding flavour, though not that of the Brambling, best in this class and a distinctly good hop" (Factor B); "Golding flavour" (Factor A).

†*Ref. No.* C 1.—Very vigorous and very fruitful; green bine; hop small, rounded.

1911.—"A Golding flavour, but with a peculiar twang—a good hop" (Factor B).

†*Ref. No.* C 15.—Vigorous and fairly fruitful; green bine; laterals long; hop very large, with thick strig.

1911.—"Not much flavour" (Factor B); "delicate flavour, should place it third in this class,—not so good as F 1 or B 7" (Factor A).

†*Ref. No.* E 1.—Very vigorous and fruitful; striped bine; early medium; laterals very short, hops thickly set; hop medium sized, oval, occasionally "leafy."

1911.—"Does not stand out" (Factor B); "does not appeal to me" (Factor A).

Ref. No. E 9.—Fairly vigorous; striped bine.

1911.—"Considerably better than B 9, more in it; place it second in this class; worth keeping" (Factor B); "inferior to B 7, C 15, and F 1" (Factor A).

†*Ref. No.* F 1.—Vigorous and fruitful; green bine; early medium.

1911.—"Do not like its flavour, but do like its appearance" (Factor B); "a Golding flavour; place it first, or perhaps equal with B 7" (Factor A).

Ref. No. F 16. Vigorous and fruitful; green bine; medium-late.

1911.—"Nice hop; Golding flavour" (Factor B); "good flavour" (Factor A).

Samples of three other hops which were dried were considered by Factors to show no promise as regards flavour; as no marked promise was shown in other directions the plants have been grubbed.

CLASS II.—SEEDLING HOPS OF KNOWN PARENTAGE.

Ref. No. G 18.—(Cobb's Golding × male growing among Canterbury Whitebines).—Very vigorous and fruitful; red bine; laterals long; hop rather small.

1911.—"A Golding flavour, worth going on with" (Factor B).

†*Ref. No.* G 21.—(Colegate's × male growing in Canterbury Whitebines).—Very vigorous and very fruitful; green bine; a late hop.

1911.—"Mild Colegate flavour" (Factor B).

†*Ref. No.* G 24.—(Colegates × male growing in Canterbury Whitebines).—Very vigorous and very fruitful; green bine; a late hop.

1911.—"Intensely strong Colegate flavour, a good hop; should place it before G 21." (Factor B).

†*Ref. No.* H 1.—(Colegates × male growing among Eastwell Goldings).—Fairly vigorous and fruitful; striped bine; laterals short; hops clustered.

1911.—"Strong Fuggle flavour, worth keeping" (Factor B).

†*Ref. No.* H 13.—(Saaz × male growing among Canterbury Whitebines).—Very vigorous and fairly fruitful; among the early hops; red bine; hop large, rather coarse.

1911.—"Does not stand out as a distinctly English or German flavour" (Factor B); "German flavour" (Factor A); "good Continental flavour, not rank" (Factor D).; "between English and Continental flavour" (Factor G).

† Indicates that a sample of this hop was submitted to factors in previous seasons (see this *Journal*, Vols. XIX. and XX.

†*Ref. No.* H 16.—Fuggles × male growing among Canterbury Whitebines).—Vigorous and fruitful ; green bine.

1911.—" A good thick hop, but flavour poor " (Factor B).

Ref. No. H 34.—(Canterbury Whitebine × " wild male ").—Vigorous and very fruitful ; striped bine.

1911.—" Good flavour, but not much in it " (Factor B).

†*Ref. No.* I 9.—(Saaz × red-bined, early flowering male).—Fairly vigorous and fruitful ; red bine ; hop closely imbricated.

1911.—" Nice blended flavour " (Factor A) ; " not English flavour," with remark, " disappointing, as it is a good thick hop " (Factor D).

Ref. No. I 13.—(Saaz × red-bined, early-flowering male).—Vigorous and fruitful ; red bine; hops in some seasons green, in others tinged reddish ; late hop.

1911.—" Not pleasant, German flavour " (Factor A) ; " unpleasant flavour, of damaged appearance " (Factor D).

†*Ref. No.* I 21.—(Cobb's Golding × early-flowering, red-bined male).—Fairly vigorous and fruitful ; red bine.

1911.—" Strong and not objectionable flavour, worth going on with " (Factor B).

†*Ref. No.* I 33.—(Canterbury Whitebine × male growing among " Eastwell Goldings ").—Vigorous and fruitful ; striped bine ; laterals long ; hops thickly set ; hop rounded, small.

1911.—" Golding flavour, a nice hop " (Factor B).

Ref. Nos. 10, 14, 17, 133, 141, 144, 145, 154, 163, 177, 207, 208, 212, 255.—(Fuggles × green-bined male (*Ref. No.* G 27.)

No. 10.—Weak growth ; green bine ; laterals short, fruitful ; hop of medium size.

1911.—" No Fuggles flavour " (Factor A).

No. 14.—Vigorous growth ; green bine ; laterals short, closely set, hops densely clustered ; hop rather long, pointed, of medium size.

1911.—" No Fuggles flavour " (Factor B).

No. 17.—Vigorous; green bine; laterals of medium length, closely set; hop somewhat rounded, of medium size.

1911.—"Has Fuggles flavour about it" (Factor B); "no Fuggles flavour" (Factor A).

No. 133.—Vigorous; bine green; laterals rather long; hop small, many imperfectly developed. Plant affected by drought.

1911.—"No Fuggles flavour" (Factor B).

No. 141.—Weak growth; green bine; laterals short, fairly fruitful; hops rather long, pointed, of medium size.

1911.—"Of quite distinct, new flavour; very strong and very nice; worth going on with" (Factor B); "strong new flavour, pungent or even oniony; full of 'condition,' a good hop" (Factor A); "flavour approaches the 'Black Currant' flavour" (Factor H).

No. 144.—Very vigorous; bine green; laterals long, very fruitful; hop too small.

1911.—"Has good and strong (not Fuggles) flavour, and comes first of all the seedlings of this cross; shows promise" (Factor B).

No. 145.—Vigorous growth; reddish bine; laterals long, fruitful; hop longish, rather pointed, hop of medium size or smallish.

1911.—"Nice, mild flavour (not Fuggles); shows promise, but hops unripe" (Factor B); "can detect a trace of Fuggles flavour" (Factor A).

No. 154.—Vigorous growth; reddish bine; laterals long, very fruitful; hop of medium size.

1911.—"Nice shaped hop, though flavour (not Fuggles) indifferent, raw" (Factor B); "nice flavour, not Fuggles" (Factor A).

No. 163.—Very vigorous; reddish bine; laterals of medium length; very fruitful; hop of medium size.

1911.—"No Fuggles flavour" (Factor B).

No. 177.—Very vigorous growth, striped or reddish bine; laterals long, very fruitful; hops of medium size or smallish.

1911.—"No Fuggles flavour" (Factors A and B).

No. 207.—Vigorous growth; striped or reddish bine; laterals of medium length, closely set and very fruitful; hop rather long, medium in size, "petals" rather distant on strig.

1911.—"Has Fuggles flavour about it" (Factor B).

No. 208.—Very vigorous growth; striped or reddish bine; laterals long, very fruitful; hop medium size or smallish.

1911.—"No Fuggles flavour" (Factor B).

No. 212.—Very vigorous; striped or reddish bine; laterals very long, very fruitful; hop of medium size; plant affected by drought.

1911.—"No Fuggles flavour" (Factor B).

No. 255.—Vigorous; striped or reddish bine; laterals long, very fruitful; hop of medium size.

1911.—"No Fuggles flavour" (Factor B).

Ref. Nos. 19, 162, 193, 215, 219, 239, 262.—(Fuggles × red-bine male).

†*No.* 19.—Very vigorous; bine green, in places with green stripes alternating with red stripes or red blotches; laterals of medium length, fruitful; hop small, rounded (totally unlike that of Fuggles).

1911.—"Very mild (not Fuggles) flavour; I like the shape of the hop" (Factor B); "nice flavour, not that of Fuggles" (Factor A).

No. 162.—Vigorous growth; red bine; laterals short or medium; fairly fruitful; hop of medium size or smallish.

1911.—"No Fuggles flavour" (Factor B).

†*No.* 193.—Vigorous; green bine, with reddish splotches; laterals of medium length, fairly fruitful; hop pale, pointed, of medium size, with the "petals" very distant on strig.

1911.—"No Fuggles flavour" (Factor B).

No. 215.—Very vigorous; very red bine; laterals rather long, fruitful, hops clustered; hop of medium size, with the "petals" closely placed on the strig.

1911.—"No Fuggles flavour" (Factor B).

No. 219.—Vigorous; red bine; laterals medium to long, not very fruitful; hop large, somewhat angled (resembling in size and shape the Fuggles hop). An early hop. Plant affected by drought.

1911.—" A very inferior hop; no distinct flavour" (Factor B); " no Fuggles flavour" (Factor A).

No. 239.—Very vigorous; red bine; laterals rather long, fruitful; hops densely clustered; hop of medium size, with the " petals " rather distant on the strig.

1911.—No Fuggles flavour" (Factor B); " neutral flavour, apparently neither Golding nor Fuggles; no 'rub'" (Factor A).

No. 262.—Vigorous; green bine with reddish splotches; laterals long, hop densely clustered; hop smallish and rounded, or larger, longer and pointed.

1911.—" Has Fuggles flavour, but much weaker than in Nos. 17 and 207; flavour distinctly weak altogether" (Factor B).

Ref. No. 13.—(Canterbury Whitebine × green bine male, (*Ref. No.* G 27).—Vigorous and fruitful; late hop; hops small, rounded, pale, somewhat resembling the Canterbury Whitebine.

1911.—"Nothing in it, though a pretty-looking hop" (Factor B); " inferior flavour, do not like it" (Factor A).

†*Ref. No.* 21.—(" Hammond's Wild Hop "* × green bine, late-flowering male (*Ref. No.* Z 9).—Very vigorous and fruitful; very late hop; striped bine; hops small, thick.

1911.—" Nothing in it at all" (Factor B); " good flavour, not rank, but hardly Golding" (Factor A).

Ref. Nos. 34, 38, 41, 49, 54, 125.—(Early White × male growing among Early Birds).

No. 34.—Fairly vigorous growth; fruitful; hop very large. An early hop.

1911.—" A good hop" (Factor B); " Golding flavour, inferior to Nos. 49 and 54" (Factor A).

†*No.* 38.—Fairly vigorous and very fruitful; laterals rather long; hop rounded.

1911.—" A thin hop, do not care about it" (Factor B); " of inferior, not Golding flavour" (Factor A).

No. 41.—Fairly vigorous; straggling growth; laterals long; hop medium sized.

1911.—" Does not appeal to me" (Factor B); " Golding flavour" (Factor A).

* See this *Journal*, vol. XIX., p. 373.

†*No.* 49.—Vigorous and fruitful; early; straggling growth; hop large, rounded.

1911.—"I like this hop" (Factor B); "Golding flavour and placed first of the seedlings of this cross" (Factor A).

†*No.* 54.—Vigorous and fruitful; early; laterals medium length; hop large, broad.

1911.—"Golding flavour, and placed second of the seedlings of this cross" (Factor A); "does not appeal to me" (Factor B).

†*No.* 125.—Vigorous and fruitful; laterals short, hops closely set; hop with golden tinge on ripening.

1911.—"Of inferior, not Golding flavour" (Factor A); "much the best of the seedlings of this cross, being a nice thick hop, and certainly a Golding. All the samples from the seedlings of this cross are marketable hops, all have a Golding flavour (though not very pronounced) and all are certainly Goldings" (Factor B).

Ref. No. 57.—(Saaz × male growing among Eastwell Goldings).—Vigorous and fruitful; medium-late; nice-sized hop.

1911.—"Good German flavour" (Factor A); "pleasant flavour; good Fuggles character" (Factor D); "distinct German flavour" (Factor G).

Ref. No. 61.—(Saaz × male hop growing among Eastwell Goldings).—Fairly vigorous and fruitful; late hop.

1911.—"Good, mild English flavour" (Factor A); "better than No. 70, but no distinctive flavour, and rather thin" (Factor B); "mild, but weak flavour; a pretty hop, but disappointing" (Factor D).

Ref. No. 64.—(Saaz × male growing among Eastwell Goldings).—Vigorous; not very fruitful; early hop; hop large.

1911.—"German flavour, not choice; no merit" (Factor A); "poor, thin hop" (Factor B); "unpleasant flavour" (Factor D).

Ref. No. 70.—(Saaz × male growing among Eastwell Goldings).—Fairly vigorous and fruitful; late hop.

1911.—" Good flavour, English in character " (Factor A); " absolutely useless " (Factor B); " negative flavour, a poor, weak hop " (Factor D).

Ref. No. 72.—(Saaz × male growing among Eastwell Goldings.—Vigorous; not very fruitful; large hop.

1911.—" Choice English flavour predominant " (Factor A); " a big hop, with good flavour " (Factor D).

Ref. No. 74.—(Saaz × male growing among Eastwell Goldings).—Fairly vigorous and fruitful; late hop; straggling habit.

1911.—" Good English flavour " (Factor A); " very mild, lack of flavour " (Factor B); " has the distinct Saaz flavour " (Factor G); " good mild flavour, a nice hop " (Factor D).

†*Ref. No.* 76.—(Saaz × male growing among Eastwell Goldings).—Vigorous and fairly fruitful.

1911.—" Very good German flavour " (Factor A); " pleasant, delicate, continental flavour " (Factor D).

Ref. No. 87.—(Cobb's Golding × male growing among Eastwell Goldings).—Fairly vigorous and fruitful; straggling growth.

1911.—" I like it for flavour, cut and appearance, but not ripe; certainly worth going on with " (Factor B).

Ref. No. 349.—(Canterbury Whitebine × red-bined male).—Vigorous and fruitful; hop small.

1911.—" Inferior flavour—do not like it " (Factor A); " nothing in it " (Factor B).

Ref. No. 350.—(A supposed Seedling (*Ref. No.* D 5*) × male (*Ref. No.* F 3).—Very fruitful; vigorous growth.

1911.—" Common, inferior, coarse flavour " (Factor A); " does not stand out " (Factor B).

In continuation of the work started in 1909, *viz.*, the collection of information as to the production of resins in different varieties of hops, a large number of dried samples of " seedling " and other hops growing in the College garden, and also samples of English and foreign hops obtained from factors and merchants, were analysed by Mr. R. H. Carter, in the College

* See this *Journal*, Vol. XIX., p. 369.

Chemical Laboratory, and their soft resins content determined by the method of analysis described by Mr. Carter in this *Journal*, Vol. XIX., p. 375. Owing to the favourable season, and freedom from "blight," the samples were remarkably even, and on this account no difficulty occurred in obtaining satisfactory duplicates for the determination of the percentage of resins. The results obtained are given below.

Tables Showing Percentage of Soft Resins.

Class I.—Hops of Unknown Parentage; believed to be Seedlings.

Reference No.	A. Per cent.	B. Per cent.	Average. Per cent.
B7	10.50	9.51	10.01
B9	6.95	7.74	7.35
B10	12.33	12.06	12.20
B18	9.78	10.48	10.13
B20	12.43	10.62	11.52
B20*	10.22	10.20	10.21
C1	11.41	10.34	10.88
C15	7.96	9.17	8.57
E1	7.82	6.77	7.30
E9	10.69	9.43	10.06
F1	8.83	9.21	9.02
F16	9.38	7.73	8.56

The characteristics of these hops are given under the reference numbers, at p. 408.

* This sample was picked ten days later than the first sample, and many of the hops were over-ripe.

Class II.—Seedling Hops of Known Parentage.

Ref. No.	A. Per cent.	B. Per cent.	Average. Per cent.
G18	8.15	7.48	7.82
G21	9.13	8.12	8.63
G24	8.80	8.17	8.49
H1	7.19	6.75	6.97
H13	10.60	10.33	10.47
H16	11.43	9.90	10.67
H34	6.52	7.68	7.10
I9	8.36	8.96	8.66
I13	7.17	6.20	6.69
I21	8.57	8.91	8.74
I33	9.09	8.72	8.91
No. 10	10.16	10.85	10.51
No. 13	8.04	7.25	7.65
No. 14	8.77	10.59	9.68
No. 17	9.74	9.48	9.61
No. 19	9.39	9.02	9.21
No. 21	9.87	9.40	9.64
No. 34	7.14	7.38	7.26
No. 38	8.62	9.01	8.82
No. 41	8.94	9.36	9.15
No. 49	6.84	7.49	7.17
No. 54	9.29	7.97	8.63
No. 57	8.63	8.60	8.62

Ref. No.	A. Per cent.	B. Per cent.	Average. Per cent.
No. 61	9.01	8.81	8.91
No. 64	8.62	8.99	8.81
No. 70	11.52	11.65	11.59
No. 72	10.71	11.07	10.89
No. 74	10.62	9.51	10.07
No. 76	10.89	9.28	10.09
No. 87	10.64	9.53	10.09
No. 125	8.68	8.64	8.66
No. 133	11.68	10.66	10.67
No. 141	10.16	9.63	9.90
No. 144	9.70	8.75	9.23
No. 145	9.01	7.82	8.42
No. 154	9.87	11.39	10.63
No. 193	7.56	8.13	7.85
No. 349	10.47	9.82	10.15

The characteristics of these hops are given, under their respective numbers, at p. 410.

CLASS III.—GERMAN VARIETIES OF HOPS GROWN AT WYE COLLEGE SINCE 1902.

Name of Variety.	A. Per cent.	B. Per cent.	Average. Per. cent.
Upper Bavarian (Halladau) ..	7.08	7.16	7.12
Auscha Green ..	13.28	12.48	12.88
Holledau (from Marzill) ..	10.08	9.26	9.67
Schwinzingen ..	9.73	8.74	9.24
Stirn ..	8.93	8.93	8.93
Saaz (Halledau) ..	11.13	10.54	10.84
Upper Bavarian ..	8.99	8.76	8.88
Lower Bavarian ..	11.11	10.35	10.73
Alsatian ..	12.26	10.97	11.62
Early Spalt ..	8.35	9.77	9.06
West Prussian ..	11.63	11.57	11.60
Baden ..	11.04	11.31	11.18
Late Bavarian ..	13.93	14.58	14.26
Elsass ..	12.35	12.68	12.52
Late variety (name unknown) (Ref. No. 78-9) ..	10.90	10.96	10.93
Ditto (Ref. No. 190-1) ..	11.09	12.02	11.56
Ditto (Ref. No. 195-6) ..	11.20	11.98	11.59
Ditto (Ref. No. 205-6) ..	12.18	11.83	12.01
Ditto (Ref. No. 216-7) ..	11.90	11.91	11.91
Ditto (Ref. No. 260-1) ..	15.03	15.06	15.05

CLASS IV.—EARLY VARIETIES.

Name of Variety.	A. Per cent.	B. Per cent.	Average. Per cent.
Early Bird (grown at Wye College	12.88	11.60	12.24
Prolifics ,,	7.81	7.01	7.41
Early Hobbs ,,	8.19	6.63	7.41
Old Golding ,,	11.70	10.90	11.30
Mathon ,,	10.85	11.63	11.24
Canterbury Whitebine ,,	9.55	9.70	9.63
Colegates (from Kent) ..	10.66	10.70	10.68
†Fuggles ..	10.15	9.71	9.93
†East Kent Goldings ..	8.45	9.69	9.07
†Worcesters ..	11.68	10.36	11.02

CLASS V.—GERMAN VARIETY GROWN IN BAVARIA.

Name of Variety.	A. Per cent	B. Per cent.	Average. Per cent.
†Holledaus ..	9.78	8.79	9.29

† These samples were supplied by factors and merchants as illustrating " the best growths of the year."

CLASS VI.—AMERICAN VARIETIES GROWN IN ENGLAND.

Name of Variety.	A. Per cent.	B. Per cent.	Average. Per cent.
Oregon (grown at Wye College)	8.63	8.64	8.64
Palmer's Seedling (from Kent) ..	11.33	9.98	10.66

Class VII.—American Varieties (Grown in America).

Name of Variety.	A. Per cent.	B. Per cent.	Average. Per cent.
Oregons ..	13.86	14.04	13.95

Reviewing the above Tables it is to be noted that of all the samples analysed in 1911 the Late German variety (name unknown; *Ref. No.* 260-1) stands highest with 15.05 per cent. of soft resins (see Class III.). This hop was obtained from Germany in 1902, and has been grown since at Wye. This is the highest percentage shown by any hop grown in England, among samples analysed at the College in any year. In 1910 samples from a similar German hop grown at Wye showed 14.20 per cent. of soft resins, which was the highest percentage reached by any English-grown sample in that year. In 1911, five other samples from the same, or very similar, late-flowering German variety (*Ref. Nos.*, 78-9, 190-1, 195-6, 205-6, 216-17) were also analysed (see Class III., p. 420) ; their average was 11.60 per cent., a high one for the season, as can be seen on referring to the averages shown by English varieties (Classes I., II., IV.).

The hop that comes next highest is another German variety, grown at Wye, *viz.*, Late Bavarian, with 14.26 per cent. Next come samples of Oregons, grown in Oregon, with 13.95 per cent., but passing these for the moment, we have as next highest in resins two more German varieties, grown at Wye, *viz.*, Auscha Green, with 12.88 per cent. and Elsass with 12.52 per cent. In 1909 Late Bavarian and Elsass showed likewise a high percentage, *viz.*, 13.63 per cent. and 13.40 per cent. respectively.

From the results obtained during the past three years there seems little doubt that some German varieties, after being grown in English soil for over nine years, are superior to English varieties as regards the production of resins. On this account the opinions of experts in the Borough as to the flavour of these German varieties grown in England become

of interest. The following information has been obtained on box samples :—

The *Late German variety* (name unknown) ; various samples. 1909, " A very large hop with a very weak flavour." 1910, " Has retained some of its German flavour, but lacks rub " ; " A good hop, would rank with the best Fuggles." 1911. " Strong continental flavour, good rub and appearance " ; " Mild continental flavour, with continental appearance " ; " Good continental flavour, nice thick hop, good rub " ; " Strong continental flavour, rather rank " ; " Poor, weak flavour, nice appearance."

Late Bavarian.—1909, " Has condition and a riper flavour." 1911, " Weak flavour, nice appearance."

Auscha Green.—1911, " Coarse, continental flavour, not pleasant."

Elsass.—1909, " Weak and poor flavour." 1911, " Good, full, continental flavour."

With regard to cropping powers some of these German varieties appear satisfactory, although all are unfortunately very late-flowering ; on the whole they seem worthy of trial by the commercial hop-grower, and a stock is being raised for trial on different soils. They are also being used as parents from which to raise new seedlings.

The samples of Oregon hops (grown in Oregon) which were analysed averaged 13.95 per cent., the third highest of all the samples analysed in 1911. Oregons grown at Wye produced only 8.64 per cent., due partly, if not entirely, to the fact that the variety is so late flowering when grown in England that its hops do not ripen properly. In 1910 samples of Oregons, grown in America, averaged from 10.46 per cent. to 11.81 per cent., while those grown at Wye averaged 9.92 per cent.

Among the samples of English varieties analysed in 1911, two stand out as showing over 12 per cent. of soft resins, *viz.*, Amos' Early Bird with 12.24 per cent., and a hop of unknown parentage, but believed to be a seedling (*Ref. No.* B 10), with 12.20 per cent. In 1909 the latter hop (B 10) stood out with the very high percentage of 13.95 per cent., and in 1910, with the fairly high percentage for the season, of 11.33 per cent. The reports, on box samples, as to flavour, received from experts in the Borough, have been as follows :—1909,

"A Golding hop, with fair flavour"; "Very good flavour." 1910, "Distinctly good flavour." 1911, "Not a good flavour." The hop has a green bine, and is of vigorous and fruitful growth; the hop itself is rather small. In view of its richness in resins, this hop will now be given an extended trial.

Samples of a considerable number of new seedling varieties of hops raised at Wye were tested for resin production (see Class II., p. 418). None of these show a very high percentage, although it must be remembered that the season of 1911 was too hot and dry at its close to suit many English varieties; under the circumstances the percentage of 10 per cent. or over shown by several of these seedlings must be considered satisfactory.

While on the one hand the opinion was expressed that the 1911 crop was exceptionally good, on the other it was said that the percentage of resins was below the average. Thus a well-known firm of hop merchants writes to me:—"Generally speaking, we considered the 1911 English crop quite exceptionally good from the brewing point of view, both Goldings and Fuggles being particularly stout and full of 'rub,' and we should have thought that the percentage of resins was higher than usual. In Germany the drought of 1911 was more severe even than over here, and the crop was consequently prematurely ripened, and exceedingly small. We should expect the percentage of resins to be low." Mr. A. Chaston Chapman, F.I.C., on the other hand, writes, "On looking through my books, I find that the resin percentages for 1911 growths are always on the low side, and it is quite possible that your explanation (*i.e.*, the drought) is the correct one."

The report as to the flavour, etc., of several of these seedlings is decidedly encouraging, and all the most promising hops will be kept under observation during the next few years with a view to testing their cropping powers.

In order to obtain information as to the permanence or otherwise of the continental flavour of the German varieties of hops grown at Wye since 1902, and as to the nature of the flavour of the seedling hops obtained by "crossing" German varieties with English male hops, box samples were submitted to a firm of hop merchants well acquainted with English and

continental hops. In order to see how far it is possible for experts to distinguish these flavours when dealing with unlocalized samples, some samples of English varieties of hops were mixed with the above and all the samples (thirty-six in number) were submitted, merely numbered, for a report as to whether the flavour was English or continental, and if good or rank. The results are set out in the Table on page 426.

The firm of hop merchants added the following observations :—" The general quality of the samples is distinctly good, and nearly all of them would sell well on this market. The best hop is No. 31 [Early Bird] ; other good samples are No. 1 [Upper Bavarian], 6 [Lower Bavarian], 23 [Saaz × English male hop], 35 [Old Golding], 9 and 10 [Late-flowering German variety]."

It is decidedly of interest to find that several of the German varieties, obtained in 1902 from Germany, still possess, after being grown for ten years at Wye, a strong " continental " flavour ; also that some of the seedlings obtained by " crossing " these German varieties with English male hops show the same flavour. Since, however, two samples of English varieties, *viz.*, " Early Bird " and " Old Golding " were pronounced to have a continental flavour, it would appear that in some cases the English and the continental flavours approximate so closely that they cannot be distinguished.

2.—The sending out of Male Hops to Growers in Kent and Sussex.

During the winter of 1911-12 applications were received for selected male hops from forty-two growers in Kent, Surrey, Sussex and other counties. Although over one hundred hills of male hops are grown in the College experimental hop-garden for the purpose of supplying growers with " cuts " of suitable male hops from which to raise a stock, the demand exceeded the supply, and six applicants had to be placed on our " waiting list " for next season. In all, 2,439 " cuts " of selected male hops, chosen to flower early or late, or mid

Name of hop.	Flavour.	Remarks.
1. German variety—Upper Bavarian ..	Good, full, inclined to Continental	Fine, bold, thick hop; not too coarse.
2. ,, Auscha Green ..	Coarse Continental—not pleasant	
3. ,, Marzill Holledau ..	Common Continental ..	Coarse hop.
4. ,, Schwinzingen ..	Strong Continental ..	Good rub, but full of seed.
5. ,, Stirn ..	Full Continental ..	Nice complexioned hop.
6. ,, Lower Bavarian ..	Good Continental ..	Nice soft hop.
7. ,, Late variety, name unknown (Ref. No. 216-7) ..	Strong Continental ..	Good rub and appearance.
8. ,, Late variety, name unknown (Ref. No. 260-1) ..	Mild Continental ..	Continental appearance.
9. ,, Late variety, name unknown (Ref. No. 205-6) ..	Good Continental ..	Nice thick hop; good rub.
10. ,, Ditto (Ref. No. 190-1)	Good Continental ..	Nice thick hop.
11. ,, Ditto (Ref. No. 195-6)	Strong Continental; rather rank	
12. ,, Baden ..	Good full Continental ..	Nice hop.
13. ,, Elsass ..		
14. Saaz × early-flowering red-bined English male (Ref. No. I9) ..	Not English ..	Disappointing, as it is a good thick hop.
15. Saaz × male in Golding garden (Ref. No. H13) ..	Good Continental, not rank ..	
16. Saaz × male among Eastwell Goldings (Ref. No. 76) ..	Pleasant, delicate, Continental ..	

Name of hop.	Flavour.	Remarks.
17. German variety—Saaz (Halladau) ..	Curious, mild.	
18. ,, Upper Bavarian ..	Strong, inclining to rank ..	Big, coarse hop.
19. ,, Alsatian ..	Fair ..	Rather coarse.
20. Saaz × male among Eastwell Goldings (Ref. No. 72) ..	Good ..	Big hop.
21. Ditto (Ref. No. 64) ..	Unpleasant ..	
22. Saaz × early-flowering red-bined English male (Ref. No. 113) ..	Unpleasant ..	
23. Saaz × male among Eastwell Goldings (Ref. No. 57) ..	Pleasant ..	Good Fuggle character.
24. Ditto × ditto (Ref. No. 74) ..	Good, mild ..	Nice hop.
25. Ditto × ditto (Ref. No. 70) ..	Negative ..	Poor weak hop.
26. Ditto × ditto (Ref. No. 61) ..	Mild, but weak ..	Disappointing, as it is a pretty hop.
27. German variety—Early Spalt ..	Rank; full ..	Coarse hop.
28. ,, West Prussian ..	Very rank ..	
29. ,, Late variety, name unknown (Ref. No.) 78-9) ..	Poor and weak ..	Nice appearance.
30. ,, Late Bavarian ..	Weak ..	Nice appearance.
31. English variety—Early Bird ..	Delicate Continental ..	Good soft thick hop.
32. ,, Prolifics ..	Bad and rank ..	Coarse hop.
33. ,, Early Hobbs ..	Pleasant; mild ..	Good rub.
34. ,, ,, ,, ..	Good ..	English Fuggle character.
35. ,, Old Golding ..	Mild Continental ..	Good, thick, soft hop.
36. ,, Mathon ..	Full flavour ..	Nice soft hop; good rub.

season,—to suit the hops among which they are to be planted—were sent free to growers at Smarden, Ashurst, Ruckinge, Teynham, Stone-in-Oxney, Sittingbourne, Paddock Wood, Brenchley, Chatham, Maidstone, Rolvenden, Matfield Green, Wateringbury, Otham, Horton Kirby, Barming, Sevenoaks, Sedlescombe, Goudhurst, Cranbrook, Chart Sutton, Canterbury, Marden, Southfleet and Eastwell, in Kent; Farnham in Surrey; Northiam, Pembury, Peasmarsh, Rye, Robertsbridge and Uckfield, in Sussex; Bentley and Petersfield in Hampshire; Hereford; Evesham and Malvern, Worcestershire. In the cases where "cuts" were sent to growers residing in other counties than Kent, Surrey or Sussex, an exchange of different varieties of male hops was arranged.

Hop-growers who intend to apply for male hops should note the period during which the hops among which the males are to be planted remain in "burr." If this information is sent to us, exactly suitable varieties of male hops can be supplied.

THE GROWING OF TOBACCO FOR NICOTINE EXTRACTION.

PART III.

By G. H. GARRAD, N.D.A.

In the College *Journals*, Nos. 19 and 20, full reports are published of the Experiments carried out in Tobacco Growing during the years 1910 and 1911. It was not considered necessary, after the large amount of work which was done in those two seasons, to carry on many more experiments during the summer of 1912, so that only about half an acre of the College Farm was devoted to Tobacco, and this area of land was used entirely for Variety Trials.

Remarkably good results had been obtained in 1911 with selected strains of *Rustica* and *Erbasanita*, which had been obtained, each as a pure line, by careful selection of Seed Plants preserved under bag to ensure self-fertilization from the 1910 crop. Further selection of Seed Plants was made in 1911, and it was the seed from these selections from the 1911 Select Strains that was sown in the summer of 1912.

The Tobacco seed was sown in March 27th in hot frames, in rows two-and-a-half inches apart, in the ordinary way. It germinated remarkably well, showing that Self-Pollination in no way affects the vitality of the seed, and every row required considerable thinning out. As the seedlings began to develop it was found that the rows had been put rather too close together, and it would be better another year to increase the distance between them and have them three or even three-and-a-half inches apart. This sytem of sowing the seed bed

in rows was necessary in order to keep the different varieties separate, but in ordinary commercial practice abroad it is quite common to sow in this way, though it involves a little more labour.

By May 8th, a fortnight earlier than in 1911, the plants were large enough for putting out in the field. It was hoped that by planting early there would be less risk of the plants suffering from dry weather, but as it happened the weather would have been much more favourable if the plants had been kept back and put in a fortnight later. As it was, the soil was distinctly dry when the transplanting was done, so that the plants had to be watered in and the two days following the planting out turned out to be the two hottest days of the whole summer. The plants were too large and too crowded in the frames to make it advisable to postpone the planting, so they were put in and had to take their chance. They stood the heat well and a useful rain on May 15th, six days after planting, enabled them to grow away.

The same piece of land was used as in the previous year. The field was ploughed in the autumn after the 1911 crop was off, and well worked in the spring with a Four-horse Cultivator. A few harrowings and rollings were then all that was necessary to bring the land down to a fine tilth, and an empty Seed Drill to mark out the rows for the planters completed operations. No farmyard manure was used, as it was desired to cheapen the cost of production, but a complete dressing of Artificial Manures consisting of 4-cwt. Meat and Bone Meal, 1-cwt. Sulphate of Ammonia, 1-cwt. Super-phosphate, and 1¼-cwt. Sulphate of Potash was put on just before marking out and harrowed in. A top dressing of ¾-cwt. Nitrate of Soda when the plants were well established was applied between the rows in June and hoed in.

The plants were put out in the same way as Cabbages, in rows twenty-six inches apart, and the same distance between the plants. The total cost of removing seedlings from the frames, carrying a quarter of a mile, planting out and watering in worked out at 18s. per acre, or 12s. less than the estimate given in the last Report.

On July 8th the plants were all ready for "Suckering" and a week later for "Topping." Up till then the plants had

been growing fairly well, and looked like a promising crop, but throughout July the weather conditions were distinctly unfavourable, only 140 hours of sunshine being registered during the month as compared with 286 hours in July, 1911. But it was in August, at the time when the plants were ripening and particularly required heat and dry weather, that the very worst of the summer was experienced, for in the whole month there were only four days free from rain, and the total sunshine for the month was ninety-eight hours! A comparison of the summers of 1912 and 1911 is shown below :—

	Average Daily Maximum.		*Rainfall.*		*Sunshine.*	
	1911.	1912.	1911.	1912.	1911.	1912.
June	67°F.	64°F.	2.85 in.	3.75 in.	171 hrs.	164 hrs.
July	83°F.	70°F.	0.28 in.	2.65 in.	286 hrs.	140 hrs.
August	80°F.	63°F.	1.37 in.	6.73 in.	245 hrs.	98 hrs.

Considering the coldness of the summer, the actual size of the crop obtained may almost be considered satisfactory. The weight of dry tobacco leaves averaged 1,300 lbs. per acre, but it was evident from their rusted and generally unhealthy condition that the report from the Chemical Department would be a very bad one, and this proved to be the case. The plants were left growing as long as possible in the hope that there might be an improvement in the weather, but the change never came and the crop was cut with a hedging slasher on August 28th. The plants were tied on to sticks and hung up in the rafters in a covered yard at Coldharbour Farm, as described in the previous reports. When thoroughly dry, the leaves were stripped off the stalks, weighed, and sampled, and the samples analysed for their Nicotine Content.

The report from the analyst was even more disappointing than was anticipated, for whereas in 1911 the percentages of Nicotine ranged from 5.55 per cent up to 8.01 per cent, in 1912 the figures ran from 1.26 per cent to 3.42 per cent. Theoretically, the figures should have been better than in 1911, because a second selection of seed plants had taken place, but the actual results obtained were as follows :—

	1911.			1912.		
	Air-dry leaves.	Nicotine in leaves.	Nicotine per acre.	Air-dry leaves.	Nicotine in leaves.	Nicotine per acre.
	lbs.	per cent.	lbs.	lbs.	per cent.	lbs.
(*a*) Rustica (Ireland, 1909) Selection No. 1	2820	8.01	226.3	1270	2.77	35.2
No. 2	2520	7.69	194.1	1240	2.49	30.9
No. 4	2590	7.97	206.2	1480	2.81	41.6
(*b*) Rustica (India, 1909) Selection No. 1	2460	5.93	146.0	1120	3.42	38.3
No. 2	2520	5.82	147.0	1380	2.52	34.8
No. 3	2430	6.18	150.3	960	2.89	27.7
No. 4	2560	6.72	171.8	740	3.33	24.6
(*c*) Erbasanita (Italy, 1909) Selection No. 1	2900	5.98	173.8	1580	1.94	30.6
No. 2	2620	5.86	153.6	1380	1.44	19.9
No. 3	2780	5.55	154.2	1370	2.75	37.7
No. 4	2920	5.67	165.6	1620	1.26	20.4
No. 5	2650	5.86	155.3	1350	1.54	20.8
No. 6	2790	5.80	162.0	1300	1.99	25.9

The general conclusion to be drawn from these figures, taken in conjunction with those of previous years, seems to be that the weather is undoubtedly the determining factor in deciding the yield and Nicotine Content of Tobacco when grown in this country. In an exceptionally good year as much as 226 pounds Nicotine can be produced per acre, but in an exceptionally bad year the same variety of tobacco on the same soil may yield only 35 lbs. of Nicotine. It is possible that the land having been two years under Tobacco may have

affected the second crop, but this seems unlikely because the field received a liberal dressing of artificials and there was nothing to complain of in the texture of the soil. Moreover, when the 1912 tobacco crop was off, the field was sown with wheat, and it is a significant fact that that part of the field which has carried two crops of tobacco has given a very much better plant of wheat than the rest of the field, which was Red Clover. Tobacco can be grown year after year on the same field abroad, and there seems to be no reason to doubt that the same can be done in England. It appears, therefore, that the soil had not been impoverished by the growth of two crops of tobacco, in fact the manuring and the constant stirring of the soil had probably improved it, and in the writer's opinion the enormously different results in 1911 and 1912 were due almost entirely, if not wholly, to the weather.

But even though the results in 1912 were so disappointing as compared with 1911, it must not at once be concluded that in every alternate season the crop is likely to be a failure. It does not need a very large crop to make the growing of insecticidal tobacco cheaper than the purchase of pure nicotine. The price of the pure article shows no signs of going down in price and still remains at about 15s. per lb. The question, therefore, arises—How much Nicotine must a farmer be able to grow per acre, if he is to produce it cheaper than the price charged by the chemist? The cost of growing an acre of tobacco, including the drying of the leaves and the extraction of the nicotine, was estimated in the last report at about £27 per acre, but there are several items which the writer now considers can be considerably reduced. In experiments carried out in Ireland, in 1910, the estimated total cost per acre was £18 13s. 5d., so that about £20 per acre may be considered to be a fair charge. Supposing then that the farmer can grow tobacco at £20 per acre, and has to pay 15s. per lb. for his nicotine at the shop, it follows that if he can produce only 27 lbs. nicotine off his acre of land, he is growing his insecticide at less cost than the price he would have to pay for it. The following table shows that even in the disastrous summer of 1912 we were able to grow nicotine at 9s. 7d. per lb., whereas, in the particularly favourable summer of 1911, we were able to produce it at 1s. 9d.

COST OF GROWING NICOTINE.

	1911.		1912.	
	Nicotine per acre.	Cost per lb. at £20 per acre.	Nicotine per acre.	Cost per lb. at £20 per acre.
	lbs.	s. d.	lbs.	s. d.
(*a*) Rustica (Ireland, 1909)				
Selection No. 1	226.3	1 9	35.2	11 4
No. 2	194.1	2 1	30.9	12 11
No. 4	206.2	1 11	41.6	9 7
(*b*) Rustica (India, 1909)				
Selection No. 1	146.0	2 9	38.3	10 5
No. 2	147.0	2 8	34.8	11 6
No. 3	150.3	2 7	27.7	14 5
No. 4	171.8	2 4	24.6	16 3
(*c*) Erbasanita (Italy, 1909)				
Selection No. 1	173.8	2 3	30.6	13 1
No. 2	153.6	2 7	19.9	20 1
No. 3	154.2	2 7	37.7	10 7
No. 4	165.6	2 5	20.4	19 7
No. 5	155.3	2 7	20.8	19 2
No. 6	162.0	2 6	25.9	15 5

But then there arises another question. An ordinary farmer purchases very little nicotine at 15s. per lb., because he cannot afford it. What price can he afford to pay? In the last report 5s. per lb. was suggested as a figure at which it could be used economically on a large scale. By growing his own tobacco, can he produce it at this price? In 1910 it cost us about 8s. per lb. to produce, in 1911, about 2s. 6d., and in 1912 about 12s. The answer, therefore, is that nicotine

is not likely to be produced in every season at 5s. per lb., nor even on an average of seasons, but it should be possible in most years with proper management and under suitable conditions to grow this Insecticide at a considerably cheaper rate than its present cost price. In an average season the cost of production may be put at somewhere about half the price charged by the chemist at the present time.

The actual extraction of the nicotine after the crop is dried is perfectly simple, consisting merely in soaking the leaves in water as described in the last report. To get the most complete extraction the leaves should be treated with three successive quantities of water. Suppose, for example, it is required to make an extract from 100 lbs. dry leaves containing 4 per cent. nicotine. These leaves should be put into a tank with 100 gallons of cold water and left for several hours. The water is then run off into a large tank at a lower level and then another 100 gallons of cold water run in. This, again, is run off after a few hours into the larger tank and a third quantity run in. We thus get 300 gallons of wash which, with a 4 per cent. tobacco, may be safely diluted down to 500 gallons. The exact quantity of wash which can be made from 100 lbs. of leaf will, of course, depend on the percentage of nicotine present in the leaf. If the tobacco contains 6 per cent. nicotine, 100 lbs. of leaf will make 750 gallons of wash; if the tobacco contains 3 per cent nicotine it will only make half this quantity of wash. It is necessary before starting to have an analysis of the tobacco made in order to find out exactly how much wash it is capable of making.

The above system of extracting is clumsy, involving a very large amount of tank accommodation, but no method has yet been discovered of overcoming this difficulty. The system can be simplified somewhat by soaking the leaves directly in the quantity of water required for making the wash, though the extraction is not quite so complete when this method is adopted, but it means a certain amount of saving of time and less trouble. In any case, however, a large amount of tank accommodation is essential.

In this connection there is another possible opening for the grower in insecticidal tobacco which may be worth considering. A question addressed to the proprietor of a large nicotine

factory in the north of England, as to whether he would be willing to purchase coarse tobacco from the growers elicited the following reply:—"I am certainly of opinion that tobacco suitable for a nicotine factory may be grown in this country. Its value depends on its strength. I do not consider 2d. or more per lb. too high for strong tobacco." This looks as if a market might be provided for a man who can grow tobacco, but either does not require the extract or has not the tank capacity for making it.

Home-grown tobacco wash was tried at Wye during the past summer, on the Hop Aphis and two or three other pests, on a large scale, and the result was completely satisfactory. The effect was also tried of mixing in soft soap with the tobacco wash, but at the first attempt the result was found to be disastrous. Directly the strong solution of soft soap came into contact with the tobacco extract, the soap immediately curdled and formed a scum all over the tank which blocked every nozzle in the spraying machine. It is, as a rule, desirable to add soft soap to the wash because it makes the wash more efficient, and it is possible, when the soap is used in addition, to reduce the strength of the tobacco wash by about 20 per cent., *i.e.*, 100 gallons of the wash can be diluted down to 120 gallons, but the mixing must not be done in the manner described above.

There are two ways in which it can be done. The best way is to start by dissolving the soft soap in the water (3 lbs. per 100 gallons), thus making a very weak solution, and then to soak the leaves in this solution. No curdling will result so long as the soap is in first. The other method is to add a strong soap solution to the tobacco wash, as previously described, but before doing so to put in some strong caustic soda. Care must be taken not to add too much caustic soda, or the wash will burn the foliage. The exact amount required can be determined previously by experimenting, by taking a measured quantity of the wash (say half-a-pint), and finding out the smallest quantity of caustic soda necessary to prevent the formation of curds when the soap is added. But the first method is the better one, and is the one to be recommended, because it is found that a weak solution of soft soap extracts rather more nicotine from the leaves than does

ordinary soft water, besides increasing the general efficiency of the wash.

The use of hot water instead of cold for the soaking of the leaves is not recommended because the result will be only very slightly superior and certainly will not repay the cost of heating. Boiling water should never on any account be used, because nicotine is exceedingly volatile and a considerable proportion of it would pass away in the steam and be lost altogether.

Once made, the wash can be kept for some time if a small proportion of formalin is mixed in to prevent decomposition. If this is not done, a scum tends to form on the surface of the liquid, which in the course of a few days will become sufficiently thick to block the spraying machine.

It is gratifying to know that since the last report was written the Government has realized the importance of getting nicotine wash at a cheaper rate, and has made special regulations under Section 4 of the Finance Act, 1912, in relation to tobacco growing for this purpose. The full text of these Regulations will be found in the *Journal of the Board of Agriculture* for March, 1913, and it will only be necessary to refer to them shortly here. They provide for the growth of tobacco in the United Kingdom for the sole purpose of obtaining an extract for insecticidal purposes, or for the making of Sheep Washes, without payment of duty under certain conditions. A person desirous of making use of this concession must obtain a licence from the Commissioners of Customs and Excise and must undertake, under penalty of £50, to observe certain regulations and conditions which the Commissioners prescribe. He may only grow certain varieties approved by the Commissioners. He must keep a "Tobacco Entry Book" in which he keeps a careful account of dates of planting, quantity planted, weight of crop, etc. He must give forty-eight hours notice before he starts cutting the crop so that the Excise Officer may be present, and the same notice before he makes an extract. He must produce for inspection by the Excise Officer, on his visit to the premises, all tobacco extract obtained and all tobacco refuse resulting from the process since his last visit, and this refuse must be destroyed at such time or times and in such manner as the Commissioners shall direct. These are some of the regulations. As they stand

at present they are certainly somewhat alarming, but there is little doubt that when they are put into practice they will be found capable of considerable modification. The main fact is that tobacco may now be grown in this country by duly licensed persons entirely free from duty, provided it is used solely for the manufacture of insecticides or sheep wash or for other purely agricultural or horticultural purpose.

VETERINARY NOTES.

BY

T. W. CAVE., F.R.C.V.S.

"STRUCK SHEEP" EXPERIMENTS.

Having proved, by extensive trials carried on in the field for four years, that the dosing method of protecting sheep against " struck " could not be relied upon, it was decided to revert to the former method of subcutaneous injections. As has been shown in past years, the inoculation of sheep with vaccines, prepared for use in cattle, had proved dangerous, although those sheep, which had passed safely through the two inoculations, were found to be protected against " struck." It was therefore decided to try to prepare a new and safer vaccine, which could be used for sheep with safety and yet with good effect.

A vaccine has been prepared in the Laboratory ; it has been tested on guinea-pigs, and found to protect these animals against a fatal dose of living culture of the " struck " bacillus.

It has been tried upon a number of experimental sheep at Wye, and has produced no ill effect. Having found the vaccine to be harmless, arrangements were then made to carry out a small trial in Romney Marsh. Mr. A. Finn very kindly provided a small lot of sheep, which were inoculated three times with the new vaccine. No loss was occasioned by its use, and the vaccinated sheep have been placed on dangerous ground together with a similar lot of unvaccinated sheep.

The result of this latest trial in the field will be reported in due course. Should the vaccine prove to be insufficiently strong to give protection, attempts will then be made to increase its action up to the point of efficiency, while still remaining safe to use. There is no doubt that sheep can be protected against " struck " by vaccination, but the great difficulty is to make the vaccine effective and yet safe.

PARASITIC PNEUMONIA OF SHEEP.

This disease, which is allied to "Husk," occurs in sheep one year old and upwards.

It is caused by the presence in the lungs of an entirely different species of worm, the red lung-worm (*strongylus rufescens*). This worm is reddish in colour, and from one to two inches in length. It is sometimes met with in ordinary "Husk" of lambs associated with the lung-thread-worm (*Eustrongylus filaria*), but it more frequently attacks older sheep, and is found in the small air-sacs of the lungs, where it causes consolidation of the lung tissue (pneumonia). In some way, as yet unknown, the young worms reach the lung, probably by way of the stomach, as is thought to be the case in ordinary "husk."

On reaching the lung, the young worms find their way into the smallest bronchial tubes and into the air-sacs, where they ultimately coil up and cause the formation of small hard lumps or nodules.

These small shot-like nodules can be seen and felt on the surface of the lung, immediately beneath the smooth covering membrane (pleura). These nodules are very fequently seen in the lungs of fat sheep slaughtered by the butcher. They are hard, sometimes of a yellowish colour, sometimes a dark red hue. If one of these nodules is carefully separated from the lung tissue, and is then crushed between two glass slides and viewed under the microscope the worm can be seen in its coiled up condition.

In these nodules the worms grow to maturity, and emerging, they seek the smaller bronchial tubes where the union of the sexes takes place. Later, the female worms produce large numbers of eggs, from which escape the living embryos.

The presence of these actively moving young worms in the air-sacs and smallest bronchial tubes causes consolidation of the lung to take place.

These patches of consolidation can be seen on the surface of the lung and appear as slightly raised areas of a greenish or grayish yellow colour; on scraping a section of one of these patches, and examining the exuded fluid under the microscope (2/3" objective), it is found to be full of eggs and embryos.

Many of these young worms will ultimately escape from the lungs and air-passages, and will be deposited on the surface of the ground. Here they may live in moist situations for a long time, and in water for several months. They are also capable of prolonged drying, and still retain their vitality, and will quickly show active movements when exposed to moisture. These embryos have been taken from the lungs of a ewe, and have been kept in dry sand in the laboratory for five months, and have been seen in active movement when the sand has been moistened with a little water.

It is also probable that the young worms may remain in the lungs of the original sheep and become sexually mature without the need of entering the body of any intermediate host or even of living in the soil for a time.

An interesting experiment was carried out on two lambs some months ago. A number of eggs and newly-hatched embryos was taken from the lungs of the ewe above mentioned. Those eggs and embryos together with a small quantity of water were injected directly into the windpipe of each lamb. The lambs were selected from the College flock, and were believed to be entirely free from lung worm. The lambs were kept indoors and remained healthy for three months, when symptoms of lung trouble developed, cough, rapid breathing, weakness, and exhaustion, and both died four months after the introduction of the young worms into the windpipe.

On post-mortem examination, the lungs of each lamb were found to contain many nodules and characteristic patches of consolidation, from which the red lung worms, eggs and embryos were obtained.

As these were the only lambs in the flock which became affected with parasitic pneumonia, it seems reasonable to

assume that the disease in the experimental lambs was entirely due to the parasites artificially introduced into the lungs through the windpipe. If this is what actually took place, it proves a very important point in the life-history of the *strongylus rufescens*, *viz.*, that the worms become sexually mature while living in the lung of the sheep, without requiring the aid of an intermediate host or without the need of any separate existence in the soil.

From these experiments one may conclude that the young worms may become sexually mature in the lungs of the same sheep in which they were bred.

It will thus be seen that parasitic pneumonia of sheep may be a slowly progressive disease, in which there is a gradual increase in the number of parasites present in the lungs, and a gradual invasion of wider areas of lung tissue, until ultimately the affected animal becomes weak and anæmic, and dies from exhaustion.

From the fact that many fat sheep are found to have numbers of nodules in their lungs, it does not seem likely that parasites in this stage of their development cause much trouble or irritation. It is when the parasities become sexually mature and begin to breed that we find those areas of consolidation forming in the lung tissue, and if these pneumonic areas are sufficiently extensive symptoms of ill-health are developed.

The symptoms of this form of "Husk" are by no means such as would render an accurate diagnosis easy to make. Sooner or later, if the sheep lives long enough, the animal begins to lose condition, becomes anæmic and weak. The breathing may be somewhat quickened, but there is usually very little cough. Later, the wool becomes loose and begins to fall off, and œdematous swellings form about the throat and below the bottom jaw, and death from exhaustion soon follows.

These symptoms can scarcely be termed characteristic of any particular malady, as they are commonly seen in wasting diseases due to various species of parasites. A post-mortem examination will, however, determine the exact nature of the disease. Owing to its slowly progressive character this disease may often cause very heavy losses. Sheep gradually lose condition, and die off one by one, until the whole flock may be

destroyed. In the marshes of Kent we have known the whole ewe flock to be gradually destroyed in this way.

Treatment is difficult, and does not give good results, especially where the disease has progressed so far as to cause weakness and anæmia.

The early recognition of the presence of the disease in the flock is most important, but can only be attained by the careful examination of the lungs of sheep which may die from emaciation from time to time. When the existence of the disease is assured, the whole flock should be put under treatment. Remedies given by the mouth are of little value; the most hopeful form of treatment is by intratracheal injections. All dosing of sheep by the intratracheal method should be done by the veterinary surgeon, and it must be done before the sheep become weak and emaciated, otherwise the operation may prove rapidly fatal.

Good nutritious dry food is necessary, together with suitable tonics.

Preventive measures, such as dressing the pastures with common salt, gas lime, etc., have been recommended, but it is doubtful whether much good is done. Owing to the tenacious vitality of the young worms, which can live in damp situations or in water, and can withstand prolonged drying, it seems hopeless to attempt to destroy them in the ground by such measures. It appears that the only preventive measure likely to prove useful is the withdrawal of sheep from infected pastures for a period of not less than three years. Such land could be stocked with other animals but should have a complete rest from sheep, in order to give time for the parasites living in the soil to die out for the want of suitable hosts.

PARASITIC GASTRITIS:

PARASITES OF THE FOURTH STOMACH OF SHEEP.

During the past year, Mr. Hornby has devoted much time to the patient investigation of the life history of the various parasites infesting the stomachs of sheep, and much valuable material has been collected, which may throw some light on this obscure subject. Many trials of various drugs have been made, but as the work has not been completed it is not desirable to report fully upon it. In due course, a full account of the investigations will be forthcoming.

TUBERCULOSIS IN CATTLE AND THE NEW TUBERCULOSIS ORDER.

As is now well known, Tuberculosis is caused by the work of the tubercle bacilli, which were first discovered by Koch, in 1882. Prior to this discovery, the disease was thought to be due chiefly to hereditary conditions, but during the last thirty years scientific opinion has undergone a great change. It has been shown that the disease is rarely congenital, very few calves being born in a diseased condition. Although there may be some hereditary weakness in animals born of tuberculous parents, which may render them more susceptible, even highly susceptible animals remain healthy when living under favourable conditions and removed from risk of infection. The term "tubercle," from which the word tuberculosis is derived, was used long before Koch's discovery of the specific organism, and was used to signify a nodule or small hard mass or lump of any kind. It is now only applied to the characteristic products of the tubercle bacilli. Tubercles vary much in size, and are usually more or less round in form. In the early stage, the colour is greyish, but older tubercles assume a yellow and cheese-like appearance.

Tubercles may be found in nearly every tissue and organ of the body. They usually occur in the lungs, on the serous membranes—the pleura and peritoneum—where they are termed "grapes," in the various groups of lymphatic glands, in the spleen and liver, and in the mammary gland. From these tubercles, wherever found, the specific bacilli may be obtained.

The tubercle bacilli are delicate slender rods, having a slightly beaded appearance. They have the special property of retaining the stain (used to show them up more strongly),

even in the presence of acids, and are described as "acid-fast" organisms.

The bacilli generally invade the animal's body either though the breathing organs or through the digestive organs. They may be localized in the organ or gland first reached, but in time they are liable to be carried throughout the body, causing the disease to become generalized.

When the bacilli remain lodged in a single group of glands or in a single internal organ, tubercles are slowly formed in these parts, and the animal may show no evidence of disease (except through the tuberculin test). Many cattle, which are known by the test to be tuberculous, remain in prime condition and without a sign of ill-health. Such animals, if they live long enough, will later develop symptoms of illness, and falling away in condition, become weak and emaciated, and are then known as "piners or wasters." In them the disease has become generalized owing to the dissemination of the tubercle bacilli throughout the body, and tubercles are formed in various organs and tissues wherever the bacilli have been carried by the blood-stream or by the lymphatic circulation.

It is now well understood, that because a beast reacts to the tuberculin test, it does not necessarily follow that the animal is capable of spreading infection by discharging tubercle bacilli. Where the disease exists in its early stages, only a few tubercles may be present in a single group of lymphatic glands or in one internal organ such as the lungs; in such a condition the animal may be incapable of spreading the germs of tuberculosis—the deadly tubercle bacilli—and so would be incapable of infecting other cattle, and could not produce milk in which the bacilli were present. The majority of cattle affected with tuberculosis are in this condition, in which the lesions are said to be "closed."

In the advanced stage the animal has become emaciated through the extension of the disease to various other parts of the body, and from many of the older tubercles bacilli are now escaping and are being discharged from the body. It is in the emaciated animals, the "piners and wasters," that the danger of spreading infection exists. It is the "piner" which spreads infection through the herd. It is the "piner" which

discharges tubercle bacilli in the milk. Such animals as these are said to be affected with "open" tuberculosis, and it is against them that the new Tuberculosis Order is intended to operate. During the first years it is expected that a considerable number of dangerous cattle will be discovered, but their removal from the herd will stop the spread of infection, and in this way the order will tend to check the spread of the disease to healthy beasts. As time goes on, other infected animals will pass into the advanced stage, and become a danger to the healthy, if nothing is done by the farmer to separate the diseased from the healthy animals. Dairy farmers and breeders are strongly advised, in their own interests, to have all their cattle tested with tuberculin, and to follow up the test by the separation of the healthy animals from those which react to the test. This separation of the reacting cattle from the non-reactors need not be costly. The provision of a stout wooden partition, dividing off a shed into two portions, is all that is necessary. If farmers and stock-owners would adopt this plan of isolating all reacting animals, while at the same time the Tuberculosis Order is removing all those cattle which are at present a danger to the healthy, a very great advance would be made towards the total suppression of the disease. The isolated animals, would have no opportunity of conveying infection to the healthy, when in their turn they become emaciated from disease and discharge tubercle bacilli from open lesions. It may be said that the present Tuberculosis Order can never succeed in stamping out tuberculosis, it can only deal with those animals which are a present danger to the consumers of milk and to healthy cattle. It is therefore necessary to strongly urge farmers to make full use of the tuberculin test, to act rigidly upon the facts revealed by the test, and in this way to help the Order to produce the greatest benefit which can be got out of it.

From the above, it must not be supposed that the Tuberculosis Order in any way compels or even suggests the use of the tuberculin test for the whole herd. The order only deals with two advanced forms of the disease; (1) cows suffering from tuberculosis of the udder, or any chronic hardness of the udder which may prove to be due to tuberculosis, or cows

discharging tubercle bacilli with the milk; (2) any beast which is emaciated from tuberculosis.

Such animals come under the provisions of the order, and will be removed from the herd for immediate isolation until they have been valued, and are afterwards slaughtered.

It will be the duty of the owner or person in charge of the cow or beast so affected to report the same to the local authority through the nearest pol'ce constable.

Animals reported to the police will be examined by the local veterinary inspector, who may, with the written consent of the owner or his agent, apply the tuberculin test to the suspected animal, or he may take samples of milk from suspected quarters or samples of fæces or other discharges from the animal, which may need examination for the presence of tubercle bacilli. In animals which are emaciated from tuberculosis the clinical symptoms will generally suffice to satisfy the inspector as to the presence of the disease.

In suspected disease of the cow's udder, the tuberculin test will probably be used, and if a reaction is obtained the milk from the suspected quarter will require microscopical examination. If tubercle bacilli are discovered, there will be sufficient evidence of the dangerous condition of the animal, but unfortunately the bacilli may be present in milk, and yet may be undiscoverable by microscopical examination alone. Where a cow has a chronically diseased udder, and has reacted to the tuberculin test, if no tubercle bacilli can be found in the milk by microscopical examination, a further test of the milk will be necessary. A little of the sediment, obtained by centrifuging a few cc. of the suspected milk, can be injected into a guinea-pig, and confirmation of the contamination of the milk can be obtained by this method in three to six weeks. When the veterinary inspector has satisfied himself that the suspected animal is *not* suffering from tuberculosis, all restrictions upon the animal will be removed immediately by the local authority. When, however the local authority are satisfied by the report of the veterinary inspector that the animal is suffering from tuberculosis to the degree above mentioned, the animal will be slaughtered after valuation, and compensation will be paid to the owner. The amount of the compensation

will depend on the extent of the disease as seen on post-mortem examination by the veterinary inspector. If the animal, on post-mortem examination, is found to be entirely free from tuberculosis, or if through an error no post-mortem examination has been made, full value and a further sum of twenty shillings will be paid.

If only slight tuberculosis is found, three-fourths value, less half the cost of the valuation, will be paid.

If the animal is found to be affected with advanced tuberculosis, the sum of thirty shillings, or one-fourth value, less half the cost of valuation, whichever sum is the greater, will be paid. The order carefully states the conditions which shall be considered to indicate that the animal suffered from advanced tuberculosis :—

(*a*) When there is miliary tuberculosis of both lungs.

(*b*) When tuberculous lesions are present on the pleura and peritoneum.

(*c*) When tuberculous lesions are present in the muscular system, or in the lymphatic glands embedded in or between the muscles ; or

d) When the carcase is emaciated and tuberculous lesions are present.

The order next deals with the milk question. Milk from suspected animals, whether those suffering from chronic disease of the udder or those emaciated from tuberculosis, must not be mixed with the milk of other cows, must be sterilised by boiling, and all vessels which have contained suspected milk must be cleansed with boiling water before any other milk is placed in them.

All suspected animals, while waiting the result of the examination, must be kept isolated, as far as practicable, from other bovine animals, and may not be sold or removed from the premises. The owner may, however, have the animal slaughtered if he wishes to do so.

The examination of milk, fæces and other discharges, taken from the suspected animal, may require several weeks before it will be possible to determine, with absolute certainty, the presence or absence of tubercle bacilli. This long period of waiting, while the inoculation test is being carried out, may only very occasionally be necessary, but it is certain that in

some few cases, at least, no other test except the inoculation test will be sufficient to determine the presence or absence of the bacilli.

It is hoped, however, that there will be very little delay in arriving at a decision as to the condition of the suspected animal, and that it will only be in a few special cases that the animals must be kept isolated for several weeks before their fate is determined.

Although no mention is made of the disposal of the milk from suspected animals, it may be assumed that such milk could be fed to pigs, etc., after being sterilized by boiling.

The rest of the order deals with the discovery of animals exposed for sale, in which the veterinary inspector finds suspicions of the two forms of the disease, above mentioned, and with the cleansing and disinfection of the place in which the affected animal has been kept.

As already pointed out, the value of the order can be greatly enhanced by the cordial co-operation of the owners of stock, and especially by the general application of the tuberculin test and the separation of all reacting animals from those which do not react.

DEATH OF FOWLS FROM IMPACTION OF THE CROP, DUE TO IMPROPER FEEDING.

Several times during the past year we have had our attention drawn to cases of serious mortality among fowls, which the owners thought were due to infection, but which, in reality, arose from injudicious dieting.

Cause.—In all the cases seen by us, the obstruction was caused by the consumption of indigestible food. In the worst outbreak this consisted of a morning feed of biscuit meal and soaked, cracked maize, a similar midday feed, and an evening feed of boiled wheat.

History and Symptoms.—Not all the birds of a flock are affected; the chief sufferers are the younger and more delicate individuals. The affected birds are seen to mope and to be taking little or no food. The comb is dark purple, and, when handled, one is able to feel marked distension of the crop. The bird is very weak, frequently scours, and generally dies within three or four days.

Lesions.—On post-mortem, often the only lesion is connecnected with the crop. This organ is found to be full of a sour smelling mass of food which has become bound together, and so unable to pass on. Occasionally, there is a passage through or above this mass which allows freshly taken food to pass to the gizzard. The lining membrane of the crop is inflamed and often gangrenous.

Treatment.—A radical change must be made in the feeding. In the case above quoted, we advised a morning feed of meal made from sharps and Sussex oatmeal, and an evening feed of dry wheat. Birds already affected may sometimes be relieved by massaging their crop, and, afterwards, administering a teaspoonful of one per cent. solution of hydrochloric acid every three hours. If this fails, surgical removal of the accumulated matter is the only remedy.

GENERAL NOTES.

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GENERAL NOTES.

DISTRIBUTION OF PRIZES, SESSION 1911-12.

THE RIGHT HON. WALTER RUNCIMAN, M.P., ON IMPROVED AGRICULTURAL EDUCATION.

The Right Hon. Walter Runciman, M.P., President of the Board of Agriculture, visted the College on Tuesday, October 8th, and formally declared open the additional rooms for students and the extensions of the laboratories and other rooms in connection with the research and advisory work, he also distributed the awards to the successful students.

The Principal (Mr. M. J. R. Dunstan) presided, supported by the governors, Lord Ashcombe (Chairman), Mr. J. E. Quested, Mr. H. E. H. Rice and Col. C. S. Williams. Among those also present were Lord Northbourne, Mr. R. M. Chart, (Chairman of the Surrey Small Holdings Committee), Mr. W. Allard (Kingston-on-Thames), Col. F. Cheesman, the Rev. Canon H. Jones (St. Leonards), the Rev. Canon Tindall (Ashford), Capt. F. Reid, Major G. Taylor, Mrs. R. J. Sankey (Hastingleigh), Dr. and Mrs. Colville, Capt. and Mrs. J. S. Fraser, Rev. and Mrs. Lambert (Wye), and Messrs. A. Brown, R. H. Green, A. Amos, R. Cooke (Detling), J. Garratt (Meopham,) E. Hardy (Chilham), J. J. Hewitt (Greenhithe), J. Hobbs, T. F. H. Waddell (Mersham), L. R. Hoole, W. F. B. Jemmett, John Long, E. J. F. Garnet Man (Benenden), F. Ivo Neame (Faversham), and others.

The Principal, in opening the proceedings, expressed his appreciation of Mr. Runciman's visit, and of the strong

support he was giving to the development of agricultural education and research.

The number of students at the College was:— 165 attending the long courses, 34 the special course for farmers' sons, and 69 schoolmasters, making a total for the year of 268 individuals attending the College, a number which is greater by 50 than any preceding record (applause). During the year a special short course was established for farmers' sons and the attendance at that short course was nearly double that which was expected, thus showing to the Governors that the policy was a satisfactory one as catering for a class of the community which requires special attention. If a farmer asks what he shall do with his son in the matter of specialized education to fit him for a career as a farmer, the reply would be that the farmer, as a successful man, should teach the son all the principles on which the father's success depends and let him come to the College for a short course, or for such time as he can be spared, so as to gain a necessary scientific and theoretical knowledge. The Board of Agriculture and Development Commissioners have realized this need and by the establishment of such courses at farm institutes the gap in our educational system of to-day will be closed. The long course students are drawn from all classes of ratepayers who contribute to the upkeep of this College, and an indication of the utility of the teaching of the College is the occupations of students after leaving us. We are here to teach young men how best to earn their living by agricultural pursuits, and 80 per cent. of the students who have gone through the College Courses are engaged in occupations connected with agriculture, a sign that the College justifies its existence (applause). And a point which I think might also be mentioned is the demand that appears to exist for Wye men, not only students, but members of our staff, and, in fact, it is almost impossible to retain some of our best men on the staff, and in some cases to retain students to complete their courses, the demand seems to be so keen. During the last year we have lost three members of the staff whom we could ill afford to lose. I mention first Mr. Mackintosh, who has gone to the newly established dairy department

of the Reading College. As you know, it has been the policy of the Board of Agriculture to specialize in research work at various centres, and Reading has collected all those men in the country who have made a speciality of dairy investigation so as to have a staff for dealing with dairy problems. Mr. Mackintosh was selected for this, and although I grieve at his loss, I must congratulate Reading on their acquisition. I would also mention Dr. Auld, who was also with us, and who has also been taken by Reading as Agricultural Chemistry Professor, and Mr. Robinson, who has taken a farm of his own. At Reading the director of the Agricultural department is a Wye man, the dairy expert is a Wye man, the chemist is a Wye man, and the botanist is a Wye man, and there are three other men on the staff who worked with me before I came here, so I think we may say Reading and Wye are closely connected. During the past year the enquiries by farmers, hop growers and fruit growers have totalled over 6,000, showing that some people regard the information they get from Wye, if not of use, at all events of interest. We have carried on for three years investigations into dairying and the feeding of milking cows and generally into the business side of the milk producing industry, and I think I may say that the work now being carried out among the farmers of Surrey and West Kent has been productive of very great good. Some twenty farmers are now being visited each fortnight by one of our experts to report on the food of the cows; samples of the milk are sent here to be analyzed, and we shall issue a report which should be of much value to them as to arranging their feeding rations. This work has been carried on by Mr. Mackintosh and Mr. Chandler. Mr. Garrad will now take Mr. Mackintosh's place, and it is intended to institute a contributory scheme whereby certain farmers who wish to have their foods valued and milks tested will pay a certain amount towards the expense. Next we come to the work being done in the hops and fruit departments. The work of Mr. Salmon with regard to hops in Kent has been fully appreciated. The number of male sets and of cuts of new varieties for testing, which we have sent out is greater than before, and shows promise of further extension. In the case of fruit, the work on

spraying and washing by Mr. Smith, Mr. Salmon and Mr. Theobald, and of apple packing by Mr. Wellington, is bearing excellent result. It may be interesting to state that at our first Kent Commercial Fruit Show at Ashford, we showed something like 500 boxes of fruit packed in boxes. This year Mr. Wellington tells me the entries already exceed a thousand for the same show (applause). That shows that there is a certain amount of appreciation by the fruit-growers of some of the work we have been able to do. The work on tobacco growing has been the means of obtaining a concession from Mr. Lloyd George in the Finance Bill, and in the future fruit-growers will be able to grow tobacco from which they can make the wash necessary for hop gardens, etc., and the agricultural community will be greatly indebted to Mr. Runciman for the part he has taken in obtaining that concession. With regard to lectures in the county, the list this year is almost double the list we had last year, and we have requests for lectures and demonstrations from the National Farmers' Union branches and from other organizations. The number of samples sent in for analysis also shows a considerable increase. The short course we established for farmers' sons we are further extending this year and we have hopes in time to do something for the small holder, either at this College or at a subsidiary centre, because we feel that they are a class of community we cannot reach here as the time and expense is too serious a matter for them to attend at this College. The Kent, Surrey and Sussex County Councils are considering whether they should not have a farm institute at a centre where short courses can be carried on at convenient times of the year. We must remember, if we carry on courses for this class of persons, we must carry them on at a time when they are not wanted on their farms.

The present term shows us to have the highest entry of students on record. The number actually entered at the present time is 151, and out of these 151 no less than 81 come from the contributing counties of Kent and Surrey. That is a result we have never had before, the highest number of students from these counties hitherto being 64, so I think from the County Council's point of view, if we

have justified their grant in previous years, we have more than justified it in the present year.

The extension of buildings which Mr. Runciman will declare open to-day is not entirely, in fact is only slightly due to the increased number of students. We have added twelve new students' rooms, but the greater part of the buildings is for the extension of our advisory and research work. There will be better accommodation for Mr. Salmon, Mr. Theobald and Mr. Cave, for which they have patiently waited for some time, a drawing office, and laboratories for research work. We have already put up a veterinary laboratory, but we require some outside building where we can keep stock for inspection and away from other stock and College buildings, and which will also be available for post-mortem examinations. We can then make full use of the advisory grant which the Board of Agrculture has given us for advice to farmers in Kent, Surrey and Sussex.

There is no doubt that this College will play an even larger part in the agricultural education and investigation in the future than in the past. The Board of Agriculture and Development Commissioners have divided England into some twelve areas, and to one of these areas Wye College is allotted, and I think we shall be able to do a great amount of good in extending our advisory and research work and tackling some of these problems which affect fruit-growers, hop-growers and agriculturists.

Then with regard to the internal work of the College. It is obvious to those watching the College lists that the number of students taking our College diplomas shows a decrease every year, this is due to the fact that the London University degree in Agriculture attracts students who would otherwise take our diplomas. Our students are again attracted to the Surveyors' Institution which takes place at a time of the year earlier than our Diploma examination.

The next point is the question of research in fruit growing. You remember, sir, that I brought a number of fruit-growers to ask you to establish a research station for fruit-growing in Kent, and with us we brought a memorandum signed by 250 growers, representing 23,000 acres of fruit. You could not accede to our request because it was thought best to establish

this in the West of England. I have no doubt that in your mind you thought that Kent and Surrey and Sussex, owing to the proximity of Wye, were better looked after than the West of England. But the Board said they would make a grant of £500 per annum towards the cost of a research station in this district, and we are anxious to get this. The Education Committee of the Kent County Council has given £1,500 towards the £2,500 necessary for equipment of a station consisting of twenty-one acres. The Board would then make a grant of £500 per annum towards the upkeep, and if we can get this then we shall be able to do something for fruit-growers. We have not got representative conditions for commercial fruit-growing on the College farm, and what we do here cannot be taken as exactly typical of what should be done on the fruit-growing soils. We want twenty acres of the best land in the South-East of England, and I hope this project will not be allowed to fall through and that the growers and those interested in fruit-growing will put their shoulders to the wheel, and that no difficulty in getting this money for preliminary expenses will be experienced. There are other matters in research which we hope also to extend, on parasitic troubles of sheep and Mr. Cave's researches in "Struck" sheep.

Lastly, with regard to the aspect of sport, I am glad to say once more that the position in which the students in this College put sport is the right one, and I must thank Mr. Haines for his assistance in this direction.

I can thankfully say that with Governors such as I have, the policy of the College is administered on the most friendly and most successful lines, and I hope the association of myself with them, which has been on such friendly lines for the last ten years, may long continue.

There is one face we miss here to-day, a man to whom we owe as much as to anybody because of his work, and that is Mr. Brooke-Hunt. He started when there was no agricultural education, and we may fairly say a great deal of credit for our present system of agricultural education is due to Mr. Brooke-Hunt. I should not like to conclude without thanking the Board of Agriculture for all they have done in helping on the work of our College, and being at our back, when

we wanted assistance, on every possible occasion (loud applause).

Mr. Runciman, who was received with loud applause, said :

"Mr. Dunstan, My Lords, Ladies and Gentlemen,

" I am glad to think the proceedings this afternoon have met with only one interruption, and that of such a friendly nature, which we have received, from the photographer in the corner. I would like to begin by saying with how much pleasure I have seen the Wye College and the surrounding work which is done by your staff and your students this afternoon, and I have to declare the additional buildings, which have recently been added, as now formally open (loud applause). Last night many of the students occupied the new rooms and I believe that they will find their quarters no less comfortable than those that are to be found in the old buildings. I wish there were more rooms in College, for although I hear that there is a considerable demand for lodgings out of College, there is no doubt that the corporate College life is one of great value to every college, even agricultural colleges. Well, sir, you have referred to the work of the College during the past twelve months, and I would like to congratulate the students and the staff upon the excellent work which has been done. I would also like to congratulate Wye College for the demand for the students. While I was at Reading I was looking at the list of those who were associated with Reading University College and I was glad to find it is from Wye, from Wye principally if not entirely, that the staff of that excellent College has been drawn. I would not like to say that all good things come from Wye, but certainly a good many of them have come from Wye, and I need hardly tell you that the Board of Agriculture is conscious of the excellent service rendered to the rural industry by this College here. Now, sir, you referred to the position which has been assigned quite recently to Wye College in the re-organization of agricultural education in which we, as a department, are now engaged. I would like for a few moments to speak of that re-organization. Mr. Brooke-Hunt, who did admirable work in arousing many of the educational authorities to the need of educational work on the agricultural side, had at his back

an excellent committee, presided over by Lord Rea, and Lord Rea's committee, like all committees that had considered this subject, believed that agricultural education was not a thing to be put in a watertight compartment having no relation to educational work, and institutions having no relation to other educational institutions, and they thought, and that view I heartily endorse, that agricultural education ought to form part and parcel to the ordinary educational training of those who from the earliest years are to spend their time and their brains in rural pursuits. When I was at the Board of Education I had the pleasure of seeing an enormous extension of school garden work in the elementary schools, and the work which is done in those school gardens is of real value from an educational point of view. I have never seen why the official studies of modern education should not be translated into rural forms, and I was glad to find that some of the most successful work done in elementary schools was done by schoolmasters who tried to bring their work into the every-day pursuit of the parents of the children. I once saw in Cheshire an elementary school where the whole school garden was worked by the pupils, children ranging from about seven years up to fourteen, and so far from regarding that school garden work as being outside the school walls, a great many of their ordinary studies were performed in the garden itself. I remember seeing an excellent map worked out of the county of Cheshire in the mud of the garden, the outlines of the sea and rivers, with everything correct, all done by the children in the mud of the garden; and no doubt they enjoyed it better than if they had had to do it on paper in the school. They themselves made an excellent water-wheel in their school garden, and there they were taught some of the principles of mechanics. They made inside their schools a thermometer, they gauged it off, they did the glass-blowing, and even the filling of it with mercury, and all this work added such an interest to the school life, that the trouble was not to get them to go to the school but to get them to leave it at the age of fourteen.

"Now, sir, the feeling I had was that it might be repeated hundreds and thousands of times throughout the rural districts of England, and I believe if more of this was done we should

hear less of the elementary school children being driven out of rural districts to become clerks and filling other occupations other than those with which they are surrounded.

"When we have dealt with children at the earliest stages, we have not disposed of them altogether from an agricultural point of view, and I was glad to hear the Principal say that he anticipated a large extension of work amongst the smaller farmers of Kent and Surrey. The Development Commissioners have at their disposal considerable funds. They are devoting to agricultural education alone no less than £325,000 in my department, and it is my business and the business of the county authorities and colleges such as this to see that that money is well spent. I believe it can be spent not only on college work but on peripatetic work. We always have to remember that there were three classes of boys, and girls too, who have to be provided for in agricultural education. We have first of all those who cannot get away from their farms in their own villages at any time in the year. You can only take knowledge to them. The second class are those who are tied to their father's farms, but who can be free from twelve to twenty weeks. These you can provide with short courses in farm institutes or farm classes. Then there is a third class who can afford time to spend one or more years at agricultural work at an agricultural college. These three classes can be provided for largely out of the Development Commission funds which are now at our disposal, and in plotting out that work throughout England and Wales, we felt the best way to arrange it was not to take everything on a county basis. The county boundaries are all very well in their way, but now the agricultural and horticultural boundaries are of far more importance than artificial boundaries. In many parts of this south-east of England it is impossible to tell where Kent ends and Surrey begins ; all that we know is that a great deal of the work of Kent and Surrey is of the same nature and conducted in the same way and on pretty much the same soil, although there are often varieties within the limits of those two counties, yet there is a great deal in common. And in plotting England into districts we thought East and West Sussex should come into this district in order to make the organization go as far as possible. I am glad to say that the proposals which we have

put before the south-eastern counties have so far met with approval, and the joint advisory council, which we hope will link them together and so enable the counties to provide organization to cover the whole area, has already started this work harmoniously, and will shortly, I trust, receive the full support of the County Councils themselves. When that is done, it is Wye College which will become the intellectual centre, not only for Kent and Surrey, but for the whole of the four counties (applause).

"I said at the beginning of my remarks that I did not believe that agricultural education ought to be put in a water-tight compartment, even as regards agriculture itself. I can think of nothing more deplorable than that the farming class as a whole should get it into their heads that a College like this is academic and not of practical value. I know that none of you have those views, otherwise you would not be here, but there are amongst the number of farmers of every form many who have the greatest contempt for the experimenter. They think he is a gentleman of high scientific attainments and interest who is able to conduct his experiments without any consideration to the case, and the one salient fact forgotten by people in the past with regard to agricultural experiments and education is that farming, like other pursuits in life, is intended to provide men with a livelihood and income, and if the income does not exceed the expenditure you will drive people out of it, and unless your experiments can be put to commercial use they would not be taken account of. This is one of the objects kept in view by this College staff, and I am glad to think the Principal and his colleagues have so far convinced the farmers and gardeners of Kent and Surrey that practical use can be made of the problems solved here, and that they have received no less than 6,000 enquiries in the course of the last twelve months, and no doubt a large number of the answers have been of commercial value to those who have enquired. I do not want to see education put into one compartment apart from agricultural interest. Of course it must have practical value on farming work, but in order that it can be put into closer touch with agricultural interest, I wish to see the joint advisory councils take more interest in other sides of agri-

cultural work. I am making application now to the Development Commissioners—I am making no secret of it here, it is well known to the Commissioners and people outside—I am making application to the Development Commissioners now for considerable funds in order that we may help live stock breeding throughout the whole of England and Wales (applause).

"I cannot tell you the scale on which our scheme has been devised, but I can say this, that although it starts modestly it certainly has an ambitious end in view, and if what we aim at is attained we hope, before many years, we shall have provided all over England and Wales a supply, I won't say of bulls of the very first class, but certainly a much larger supply of bulls of the second class, in order that the general standard of English live stock and cattle may be considerably raised. I hope to do this on such a basis that a farmer will not have to spend more money on his breeding than he has done in the past, but will be introducing into his own herds a much more valuable and higher class of blood than has been there during the last few years. I am distressed to find in the country a great tendency, especially in the dairy districts, of farmers caring little or nothing about their cows and calves so long as milk is produced, and an instance of this in the Thames Valley has been greatly to reduce the average standard of cows of the dairy farmer. This is one of the dangers of our towns, and is in great contrast to the work that is being done by the well-to-do farmers who take a high interest in the breeding of high-class cattle. Every one knows that if a man wishes to obtain a first-class cow, horse, bull or sheep, it is to the United Kingdom that he comes (hear, hear). Now, sir, if that standard of high-class breeding which is to be found amongst a few farmers can be disseminated amongst the whole of the British farmers, I believe that in ten years we shall have entirely regenerated our stock in horses, sheep and cattle as well. I want to see this work done in conjunction with agricultural educational work and the same men who take an interest in education take an interest in live stock breeding and references. I advise these joint County Councils to exercise a great deal of the control in the organization of this live stock scheme, and I look forward to the time when Colleges

like Wye College will not only be concerned in horticulture and in solving problems, but will be exercising a large influence over breeders of cattle in this part of England. I would say this one word to the staff on the subject. If you can interest the English farmer in live stock breeding to such an extent as to level up the value of the live stock of the average farmer as well as that of the large farmer, you will have gone a long way to add not only ten but twenty-five per cent. to the agricultural produce in the course of one year. One of the greatest encouragements in this work is that its good can be seen in the early stages, and I venture to say that those students who have worked here during the last few years and who have gone away from this college, carrying away knowledge and a certain amount of training which will be of benefit to them all their lives, will not only be adding to their own attainments, but to England as well.

"As a last remark, I should like all men in public positions, whatever party they belong to, to realize that the main basis of our national wealth is to be found in the agricultural industry of this country (applause). Nothing which injures agriculture in this country can injure one class of the community alone. You may aim if you like at every one of the classes engaged in agriculture, but if you injure any one of those classes you will injure the whole agricultural community, and through injuring the whole agricultural community you will injure the whole nation on its industrial side as a whole, and the time is rapidly coming when we shall be producing more and more by intensive cultivation for the organization of the food supply of this nation. I am not one of those who believe that in time we are to be more dependent on foreign imports for food supplies. I should like to say that I have come to the conclusion that of the food required in this country certainly not less than one half of it is already produced in the British Isles. The estimate is sometimes put much lower and that is much grossly mistaken. Now, sir, I need hardly emphasize the fact that anything which is likely to injure the productivity of the industry to which one half of our food supply depends and the best portion of our human stock depends is likely to be a national injury. I hope the time is far distant when agriculture is likely to lose its

place and support of economists and statesmen. While I am at the Board of Agriculture I have only one object in view, and that is to enable the agricultural community from the highest to the lowest to make their own opportunities. That can be obtained in a hundred different ways and it is in many of these activities that I hope to expend my energy" (loud applause).

Lord Ashcombe, on behalf of the Governors, proposed a hearty vote of thanks to the President of the Board of Agriculture for the address which he had given, which was seconded by Mr. J. E. Quested.

Mr. Runciman: I am greatly indebted to you in giving me such a cordial reception and in passing a vote of thanks to me for coming down this afternoon, and I need hardly tell you that this building and those surrounding are much more pleasant than the other buildings in which I am doomed to spend a great deal of my time (laughter). I have only one remark on the subject raised by the seconder, that he need have no fear of the Foot and Mouth disease, and that we shall use every effort at our command in exterminating it wherever it shows itself. I quite understand his nervousness with regard to Irish cattle. I only wish that by the preservation of calves instead of by their wholesale destruction, which unfortunately is one of the things that happens, a large number of cattle were preserved for our own uses for store cattle. I am greatly obliged to you for the vote of thanks (applause).

Lord Northbourne proposed a hearty vote of thanks to the Governors of the College for the services which they had rendered, which was seconded by Mr. Frederic Neame (Macknade).

Lord Ashcombe returned thanks on behalf of himself and his colleagues, and took the opportunity of thanking the Principal and his staff.

The awards were as follows:

Diplomas and Certificates.

Diploma with Distinction.—H. Rosher (Veterinary Science), B. P. Tuppen (Agriculture, Agricultural Chemistry, Veterinary Science).

Certificate.—R. M. Wilson.

Farm Certificate.—A. D. LeSueur.

Horticultural Certificate.—E. A. Hulme, J. K. P. Patterson, C. W. B. Wright.

The following Students satisfied the Examiners :—

Part II. of the Diploma.—B. Allen, D. M. Archdale, H. P. Borlase, A. H. Fairbairn, T. J. Gripper, L. E. Holyman, N. Howard, J. C. Palmer, E. K. Warren, M. A. Waterer.

Part I. Diploma Standard.—H. A. Awad, H. W. Bedford, H. W. Budden, E. W. Burch, J. Deering, G. W. Hughes, A. Hopcroft, C. F. Laing, G. F. March, W. H. Kirsopp-Reed, J. R. M. Niven, E. H. Pollard, G. St. J. Rands, C. R. Wimshurst, E. N. Tennant.

Part I. Certificate Standard.—J. A. Bowyer, H. A. Catt, J. S. Elliman, R. H. Sharp.

Part I. Estate Management Course.—L. S. Charleton.

The following Students passed :—

Part III. Diploma Standard.—In Agriculture, Agricultural Chemistry and Agricultural Botany, P. E. N. Hitchins, R. S. Sennitt, G. Smith, C. E. Strickland ; in Agricultural Chemistry and Agricultural Botany, L. A. B. Sharpe.

The following will be re-examined in the subjects named :

Part III. Diploma.—E. J. Howard, J. E. Spickernell—Agricultural Botany.

First Year Certificate Standard.—D. Brodie James, Building Construction ; G. A. F. Campbell, Agriculture and Building Construction ; G. L. Chesney, Agriculture ; A. M. Earle, Agriculture and Veterinary Anatomy ; A. F. A. König, Veterinary Anatomy and Building Construction ; H. S. Robinson, Building Construction ; R. Salice, Agriculture and Building Construction ; G. M. Warner, Agriculture.

Prizes.

Degree Course.—P. E. N. Hitchins, *prox acc.*, C. E. Strickland.

Diploma.

Third Year.—Agriculture, B. P. Tuppen; Agricultural Botany, not awarded; Agricultural Chemistry, B. P. Tuppen.

Second Year.—Agricultural Entomology, H. P. Borlase, *prox acc.*, B. Allen; Surveying, Book-keeping, etc., H. P. Borlase, *prox. acc.*, E. R. Warren; Veterinary Hygiene, H. P. Borlase, *prox acc.*, B. Allen; General Work, B. Allen, *prox acc.*, H. P. Borlase.

First Year.—Agriculture, C. R. Wimshurst, *prox. acc.*, H. W. Budden, J. Deering, A. Hopcraft; Botany, C. R. Wimshurst, *prox. acc.*, C. F. Laing; Building Construction, H. A. Catt; Veterinary Anatomy, C. R. Wimshurst, *prox. acc.*, H. W. Budden, G. W. Hughes; General Work, C. R. Wimshurst, *prox. acc.*, H. W. Budden.

Horticulture.—J. K. P. Patterson, *prox. acc.*, E. A. Hulme.

Estate Management.—R. R. Huyshe.

The Agricola Prize for the greatest aggregate of marks in Third Year Diploma Work.—B. P. Tuppen.

Medals.

Plans of Farm Buildings.—L. S. Charleton, *prox. acc.*, G. H. F. Knight.

Poultry Management.—A. D. LeSueur.

The Successes of Students in Outside Examinations were as follows:—

B.Sc. Degree.—Final.—T. D. Mosscrop.

Intermediate.—O. C. Brown, A. H. Burgess, N. P. Chamney, S. D. Timson, M. M. Dumyati (referred Zoology), J. M. Templeton (referred Zoology).

Surveyors' Institution. Professional Associate Examination.—E. R. Garnett, J. S. Rutherford, G. O. Searle, R. M. Wilson.

WEATHER REPORT, 1912.

ABSTRACT OF METEOROLOGICAL OBSERVATIONS AT THE SOUTH EASTERN AGRICULTURAL COLLEGE, WYE, KENT, DURING THE YEAR 1912.

Compiled by S. ROTHWELL, from observations by H. C. CHAPELOW.

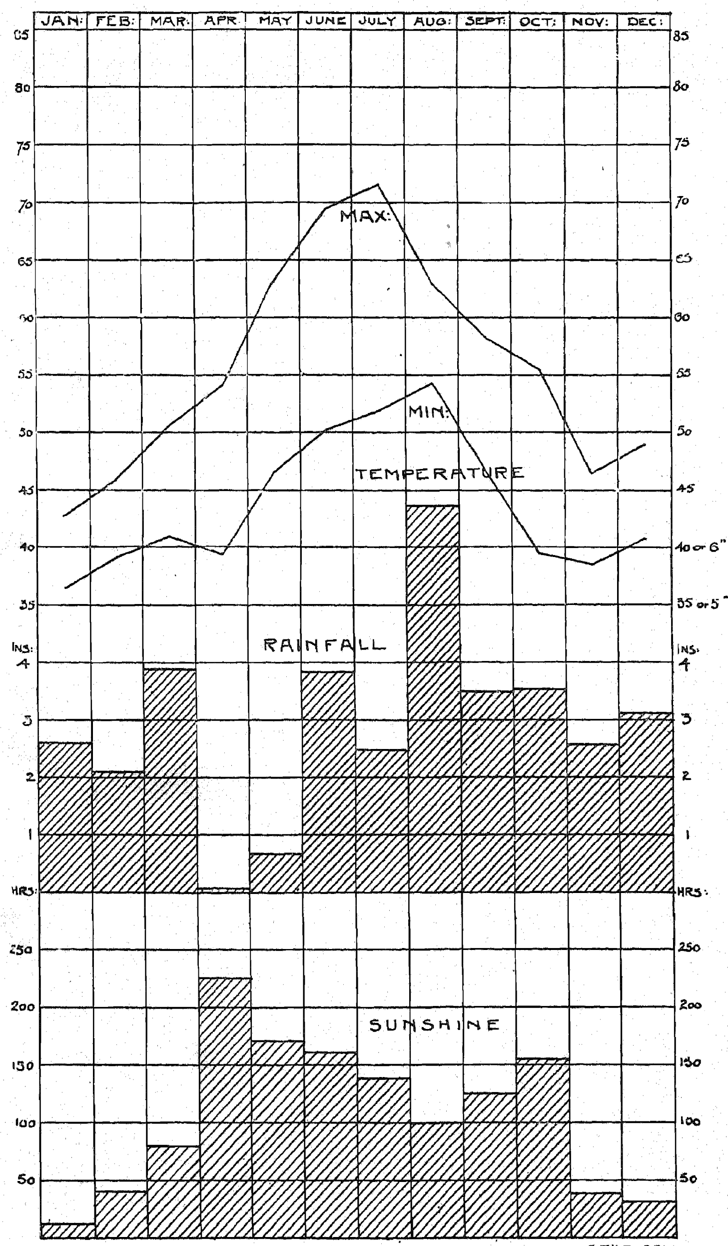
	TEMPERATURE.									RAINFALL.				SUNSHINE.			Bar. Mean.
	Mean Daily.			High-est in Scrn.	Low-est in Scrn.	Low-est on Grass.	Number of Frosts.		Soil Temp. at 3 ft. at 9 a.m.	(Inches). Total.	(Inches). Greatest fall.	Date.	No. of Rain Days.	Total.	Maximum in one day.	Date.	
Month.	Max.	Min.	Mean.				In Scrn.	On Grs.						Hrs. Mins.	Hrs. Mins.		
Jan.	42.9	36.5	39.7	50	35	13	8	11	40.0	2.63	.5	5th	20	12 25	7 0	28th	30.10
Feb.	46.0	39.1	42.5	54	15	8	5	6	38.9	2.1	.32	12th	16	40 10	6 0	11th	29.82
March	50.7	41.0	45.8	58	33	26	nil	3	42.4	3.89	.74	4th	20	82 35	11 0	29th, 30th	29.83
April	54.3	39.5	46.9	74	30	20	1	12	45.1	.08	.07	29th	2	227 45	12 0	21st, 23rd	29.99
May	63.4	46.7	55.0	73	32	25	1	4	50.5	.66	.12	15th	11	170 35	11 0	25th	29.84
June	64.7	50.3	57.5	78	44	38	nil	nil	52.3	3.75	.98	4th	14	161 55	11 30	22nd	29.69
July	71.7	52.0	64.8	89	39	36	nil	nil	58.4	2.47	.9	19th	12	139 55	9 50	13th, 15th	29.92
August	63.2	54.4	58.8	69	34	29	nil	1	55.9	6.73	1.0	25th	27	99 10	7 20	2nd	29.76
Sept.	58.4	47.0	52.7	68	42	26	nil	9	52.9	3.52	1.95	30th	9	126 35	10 0	20th	30.13
Oct.	55.5	39.6	47.5	64	28	19	6	18	48.2	3.55	.76	20th	13	154 0	9 40	4th	29.99
Nov.	46.6	38.5	42.5	55	25	16	6	13	44.7	2.55	.48	28th	15	38 15	6 20	1st	30.06
Dec.	49.0	40.8	44.9	55	32	25	1	14	40.0	3.13	.54	26th	21	32 50	5 30	30th	30.09
The Year	55.5	43.8	49.9	89	15	8	28	91	47.4	35.06	1.95	—	180	1286 10	12 0	—	29.93

Height of Station above Mean Sea Level, 150-ft.
Latitude, 51° 11″.
Barometric readings uncorrected for temperature and height above Sea Level.

Notes to above Table.

Highest Reading of Barometer during year, 30.50 on Oct. 5th, Jan. 1st and 2nd.
Lowest Reading of Barometer during year, 29.10 on May 15th.
Lowest temperature of soil at 3-ft., 35.0.
There were 79 days on which no sunshine was recorded.

A Rain Day is one on which at least .01 inch falls.



JAN: FEB: MAR: APR: MAY JUNE JULY AUG: SEPT: OCT: NOV: DEC:
MAX:
MIN:
TEMPERATURE
RAINFALL
SUNSHINE
INS:
HRS:
85
80
75
70
65
60
55
50
45
40 or 6"
35 or 5"
4
3
2
1
250
200
150
100
50

A.F.H.D. DEL:

SUMMER TEACHERS' COURSE.

This Course was held at the College from July 29th to August 10th. Sixty-nine schoolmasters attended—thirty-eight being from Kent, thirty from Surrey and one from Sussex. The number is a record and is due to the fact that for the first time teachers from the autonomous areas of Kent were admitted to the course.

The old plan of dividing the men into two groups not being possible on account of the large number, a new arrangement of work had to be devised. Under this scheme the following courses of lectures were arranged :—

Course A.—" General Botany and Plant Physiology," arranged by S. T. Parkinson, B.Sc., and G. H. Garrad.

Course B.—" Chemical Constituents of Plants," arranged by S. J. M. Auld, D.Sc., and D. R. Edwardes-Ker, B.A., B.Sc.

Course C.—" Structure and Habits of Common Insects," arranged by C. W. Jemmett and H. P. Hutchinson, B.Sc.

In selecting the subject matter of these courses special care was taken to make the work of as practical a character as possible, and suitable for the requirements of Elementary Schools. A series of lectures was delivered by Mr. E. S. Salmon on " Fungus Pests," and outdoor demonstrations were given in the afternoons on Horticultural Subjects, Surveying and Poultry Management.

Popular lectures were given in the evenings by the Rev. E. Lambert, M.A., A. Lander, Esq., H. F. Abell, Esq., and the Principal.

Satisfaction was expressed by the Schoolmasters at the way in which the Staff had carried out the work in connection with the College Association of Kent and Surrey teachers, and it was decided to continue the work on the same lines during the coming year.

STAFF PUBLICATIONS.

BY M. J. R. DUNSTAN.

Some Suggestions for the Organization of the Fruit Industry. *Report of the National Fruit Growers' Federation.*

BY F. V. THEOBALD.

1. The Aphides attacking Cultivated Peas and the Allied Species of Macrosiphum. *Journ. Roy. Hort. Soc.* Vol. XXXVIII. Part II., pp. 256-257. Nov. 1912.
2. The Aphides attacking Ribes. *Journal Economic Biology.* Vol. VII. pp. 94-115. pls. ii. and iii., fig. 14. 1912.
3. Useful Insects. *Proceedings Norwich Museum Association.* pp. 6-9. 1913.
4. Three New Culicidæ from the Transvaal. *The Entomologist.* Vol. XLV. pp. 92-93. March, 1912.
5. A new Species of Culicidæ. *Revue Zoologique Africane.* Vol. II., fas. I. Sept., 1912.
6. An Unrecorded Apple Sawfly in Britain (*Lygæonematus moestus.* Zaddach). *The Entomologist.* Vol. XLVI. pp. 108-109. March, 1913.
7. The Culicidæ collected by the Percy Sladen Trust Expedition to the Indian Ocean in 1905. *Trans. Linn. Soc., Lond.* Vol. XV. Part I. 2nd Sec. Zool. pp. 81-93. 6 figs and 4 pls. March, 1912.
8. The Aphides on Mangolds and Allied Plants. *Journal Board of Agriculture.* Vol. XVIII. p. 466. 1912., and Vol. XIX., Feb. 1913, pp.
9. Notes on Potato Aphis. *Rhopalosiphum solani.* Kaltenbach. *The Entomologist.* Vol. XLV. (June, 1912). pp. 4 + 2 figs.
10. A New Strawberry Aphis. *The Entomologist.* Vol. XLV. p. 226. August, 1912.

11. The Aphididæ of the Hastings District. pp. 13. June, 1912. (*Printed privately.*)
12. Report on Economic Zoology for the Year ending September 30th, 1912. pp. 155, figs. 11, plates, 37.

BY E. S. SALMON.

The Control of Apple "Scab" by Bordeaux Mixture Lime-Sulphur. (Leaflet, *South Eastern Agricultural College*, Jan., 1912.)

The Lime-Sulphur Wash for use on Gooseberries (*Journal of the Board of Agriculture*, May, 1912.)

3. Economic Mycology and some of its Problems. (*Transactions of the British Mycological Society*, for the season 1911 (1912).
4. The Lime-Sulphur Wash (Leaflet *South-Eastern Agricultural College*, April, 1912).
5. Lime-Sulphur Wash for American Gooseberry Mildew. (*Journal of the Board of Agriculture*, March, 1913.)

BY HENRY P. HUTCHINSON.

Tor Grass or False Brome and its Eradication from Down Pasture. *Journal of the Board of Agriculture*. Nov., 1912.

BY R WELLINGTON.

Apple Barrels; Their Sizes and Uses. *Report of the National Fruit Growers' Federation.*

BY C. H. HOOPER.

The Pollination and Setting of Fruit Blossoms and their Insect Visitors. *Journal of the Royal Horticultural Society. Journal of the Linnean Society.*

Date of Issue	Date of Issue	Date of Issue

GIPNLK—H-40 I.A.R.I.—29-4- 5—15,000